L Number	Hits	Search Text	DB	Time stamp
1	2072	(358/1.9).ccls.	USPAT	2004/07/21 17:57
2	101	(358/3.01).ccls.	USPAT	2004/07/21 17:58
3	99	(358/3.21).ccls.	USPAT	2004/07/21 17:58
4	52	(358/3.24).ccls.	USPAT	2004/07/21 17:58
5	435	(358/447).ccls.	USPAT	2004/07/21 17:58
6	317	(358/461).ccls.	USPAT	2004/07/21 17:58
7	1080	(358/518).ccls.	USPAT	2004/07/21 17:58
8	206	(358/521).ccls.	USPAT	2004/07/21 17:59
9	160	(382/169).ccls.	USPAT	2004/07/21 17:59
10	341	(((gr?y adj scale) or gr?scale or density or gradation) near2 (range or domain or distribution or spread or width or limit or length)) with (compress$4 or reduc$4 or expand$4 or expansion or amplify$4 or amplification or broaden$4 or increas$4 or magnify$4 or magnification or spread$4 or decreas$4) with (select$4 or choos$4 or choice)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/07/21 17:59
11	138	(((gr?y adj scale) or gr?scale or density or gradation or dynamic) with (range or domain or distribution or spread or width or limit or length) with (compress$4 or reduc$4 or expand$4 or expansion or amplify$4 or amplification or broaden$4 or increas$4 or magnify$4 or magnification or spread$4 or decreas$4) with (select$4 or choos$4 or choice)) and ((358/$).ccls. or (382/$).ccls.)	USPAT	2004/07/21 18:00
12	1	(setting with (compress$4 or expan$5) with characteristic) and (selecting with (compress$4 or expan$5) with characteristic) and ((compress$4 or expan$5) with gradation) and ((358/$).ccls. or (382/$).ccls.)	USPAT	2004/07/21 18:00
13	226	((((look-up or lookup) adj table) or LUT) with parameter) and (358/$).ccls.	USPAT	2004/07/21 18:00
14	8	("5319719" | "5343246" | "5493622" | "5796870" | "5991457" | "6069979" | "6072913" | "6141399").PN.	USPAT	2004/07/21 18:00
15	4	("4893177" | "5126757" | "5220350" | "5287418").PN.	USPAT	2004/07/21 18:00
16	5	("5084762" | "5398121" | "5425134" | "5502580" | "5774238").PN.	USPAT	2004/07/21 18:00
17	7	("4473029" | "4546060" | "4550254" | "4673807" | "5117119" | "5649266" | "5678132").PN.	USPAT	2004/07/21 18:00
18	35	("4064440" | "4366382" | "4511799" | "4729098" | "4737921" | "4835688" | "4903202" | "4905148" | "5022062" | "5044002" | "5098640" | "5125015" | "5166876" | "5182764" | "5206592" | "5233300" | "5291402" | "5319547" | "5345393" | "5479023" | "5490218" | "5506785" | "5528703" | "5544283" | "5548694" | "5600700" | "5606517" | "5630034" | "5638499" | "5638502" | "5642393" | "5642394" | "5647018" | "5699400" | "5712926").PN.	USPAT	2004/07/21 18:00
19	14	5117119.URPN.	USPAT	2004/07/21 18:00

20	78	5012333.URPN.	USPAT	2004/07/21 18:00
21	13	("4654722" | "4945406" | "5012333" | "5016043" | "5544258" | "5633511" | "5822453" | "5923775" | "5978106" | "6097836" | "6236751" | "6285798" | "6438264").PN.	USPAT	2004/07/21 18:01
22	11	("4340911" | "4731662" | "5012333" | "5046147" | "5123059" | "5194878" | "5237431" | "5351306" | "5414538" | "5748773" | "6108105").PN.	USPAT	2004/07/21 18:01
23	5	("5012333" | "5060061" | "5164993" | "5454044" | "5633511").PN.	USPAT	2004/07/21 18:01
24	21	5060061.URPN.	USPAT	2004/07/21 18:01
25	13	4371260.URPN.	USPAT	2004/07/21 18:01
26	9	5224178.URPN.	USPAT	2004/07/21 18:01
27	7	("5084911" | "5319693" | "5483604" | "5526442" | "5668845" | "5740267" | "5883985").PN.	USPAT	2004/07/21 18:01
28	66	(US-6608941-$ or US-6546124-$ or US-6473198-$ or US-6415038-$ or US-6417878-$ or US-6377366-$ or US-6272230-$ or US-6225618-$ or US-6198491-$ or US-6078642-$ or US-6067366-$ or US-6035014-$ or US-5896470-$ or US-5119086-$ or US-5012333-$ or US-4733306-$ or US-4379632-$ or US-4371260-$ or US-4121937-$ or US-3646262-$ or US-5117119-$ or US-6141399-$ or US-5796870-$ or US-5287418-$ or US-5502580-$ or US-4673807-$).did. or (US-6717698-$ or US-6633657-$ or US-6453075-$ or US-6285798-$ or US-6275605-$ or US-6163389-$ or US-6167165-$ or US-6047092-$ or US-5715377-$ or US-5633511-$ or US-5237431-$ or US-4731662-$ or US-5060061-$ or US-6067109-$ or US-6046827-$ or US-5224178-$ or US-4864392-$ or US-5726771-$ or US-5883985-$ or US-6314198-$ or US-6463181-$ or US-6292535-$ or US-5875304-$ or US-5799111-$ or US-6157469-$ or US-4984071-$).did. or (US-20040138569-$ or US-20040101201-$ or US-20040071365-$ or US-20040071366-$ or US-20040071349-$ or US-20040071359-$ or US-20040071348-$ or US-20030160834-$ or US-20030107763-$).did. or (JP-2000307921-$ or JP-10079855-$ or JP-58141076-$).did. or (US-6417878-$ or US-5592576-$).did.	USPAT; US-PGPUB; JPO; DERWENT	2004/07/21 18:01

US005845869A

United States Patent [19]

Makino

[11] **Patent Number: 5,845,869**

[45] **Date of Patent: Dec. 8, 1998**

[54] **PHOTOGRAPHIC ROLL FILM**

[75] Inventor: **Teruyoshi Makino**, Kanagawa, Japan

[73] Assignee: **Fuji Photo Film Co., Ltd.**, Kanagawa, Japan

[21] Appl. No.: **712,387**

[22] Filed: **Sep. 11, 1996**

[30] **Foreign Application Priority Data**

Sep. 13, 1995	[JP]	Japan	7-235127
Sep. 14, 1995	[JP]	Japan	7-236993
Sep. 25, 1995	[JP]	Japan	7-245871
Nov. 1, 1995	[JP]	Japan	7-284827

[51] **Int. Cl.**[6] **B65H 75/28**

[52] **U.S. Cl.** **242/584.1**; 242/587.1; 242/348.1

[58] **Field of Search** 242/584.1, 587.1, 242/348.1; 396/512, 513, 514, 515, 516

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,506,843	3/1985	Luhrig et al.	242/584.1
4,860,037	8/1989	Harvey	396/512
4,984,751	1/1991	Hoffacker et al.	242/584.1
5,264,886	11/1993	Byrd	396/515
5,347,334	9/1994	Smart et al. .	
5,351,904	10/1994	Mitake	242/584.1

FOREIGN PATENT DOCUMENTS

0 342 372	11/1989	European Pat. Off. .	
0 414 265	2/1991	European Pat. Off. .	
1190785	4/1965	Germany	242/584.1
2043068	11/1971	Germany	242/584.1
1251030	10/1989	Japan .	
2137842	5/1990	Japan .	
2160231	6/1990	Japan .	
2235052	9/1990	Japan .	

Primary Examiner—John M. Jillions

Attorney, Agent, or Firm—Sughrue, Mion, Zinn, Macpeak & Seas, PLLC

[57] **ABSTRACT**

In a 120- or 220-size roll film, a leader of a light-shielding paper has at least a hole to be engaged with a claw formed in a slit of a spool core. A pair of ribs are formed on an opposite wall of the slit from the claw. The ribs have a height larger than a thickness of the light-shielding paper plus a distance from a peak of the claw to the opposite wall, so that the ribs urge the leader toward the claw, and let the hole be caught on the claw. The claw has side projections which protrude in an axial direction of the spool core in proximity to the peak of the claw. Guide surfaces of the claw which face entrances of the slit are inclined toward each other, such that the hole caught on the claw is guided to be engaged with the side projections upon the leader being relatively moved away from the slit when the spool is rotated.

18 Claims, 19 Drawing Sheets

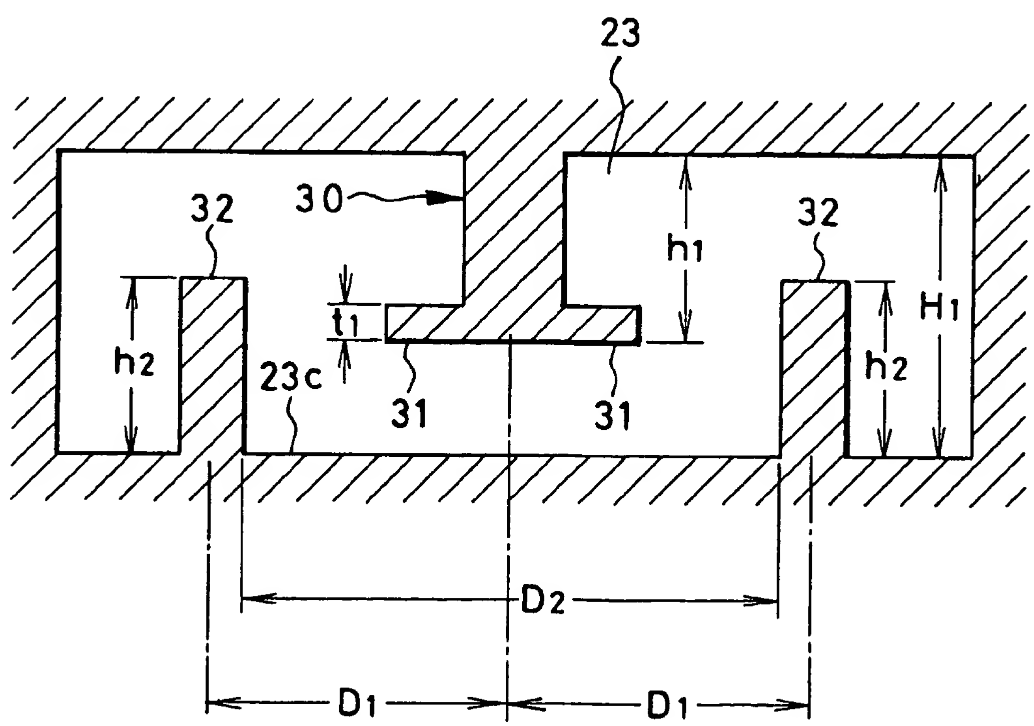


FIG. 1

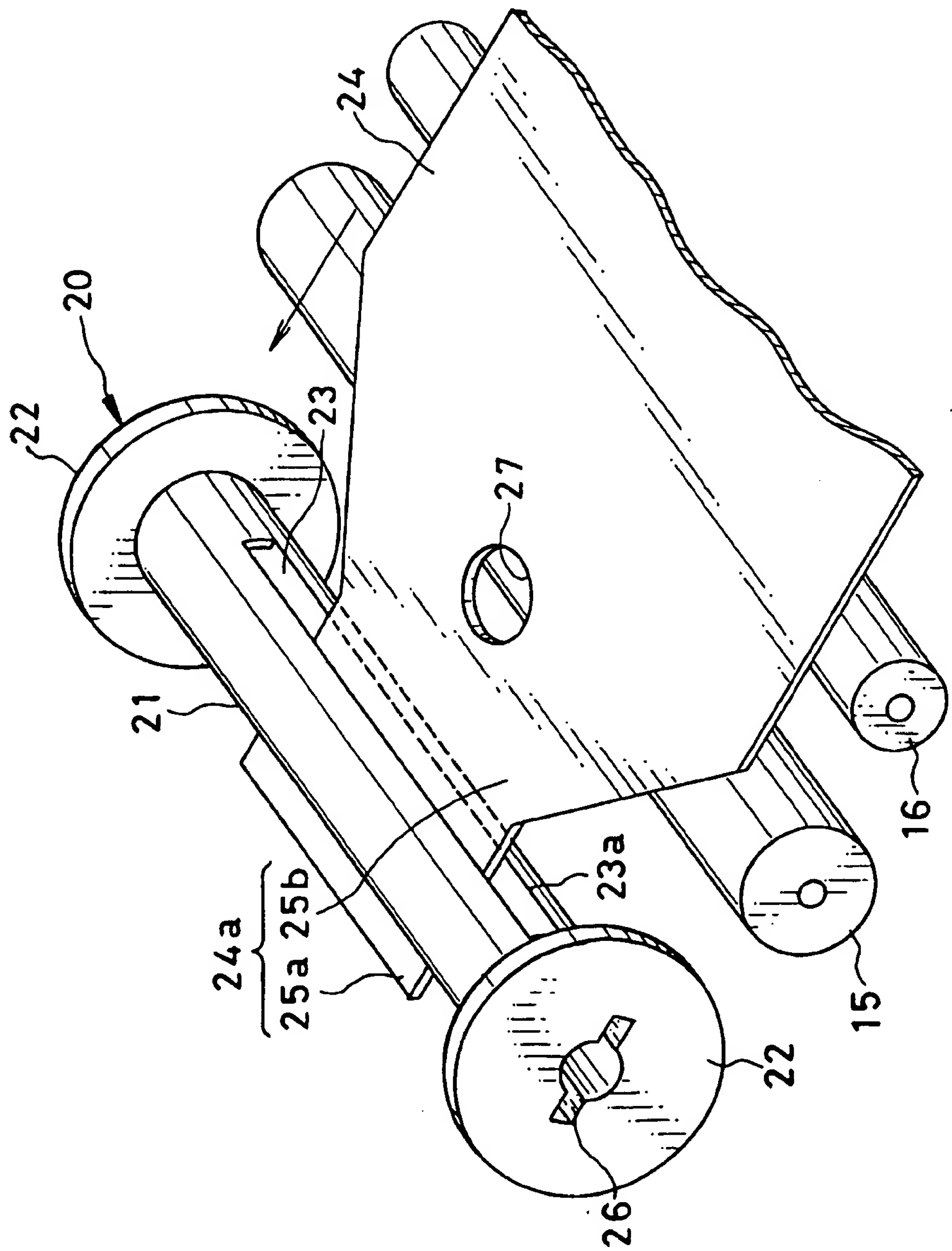


FIG. 2

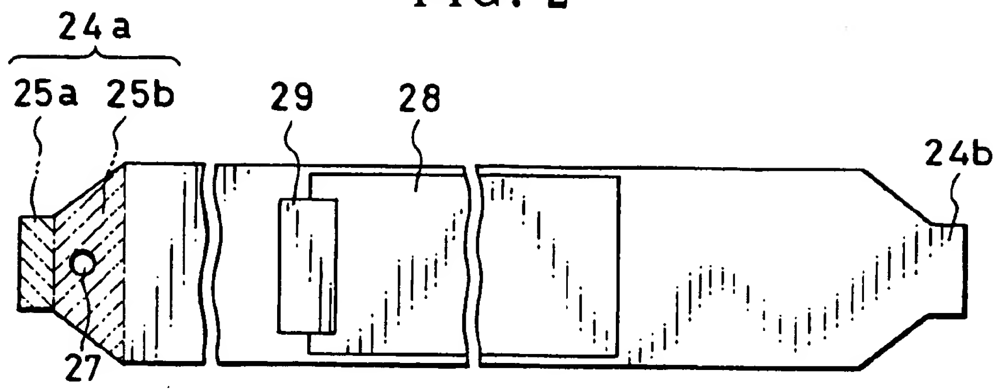


FIG. 10

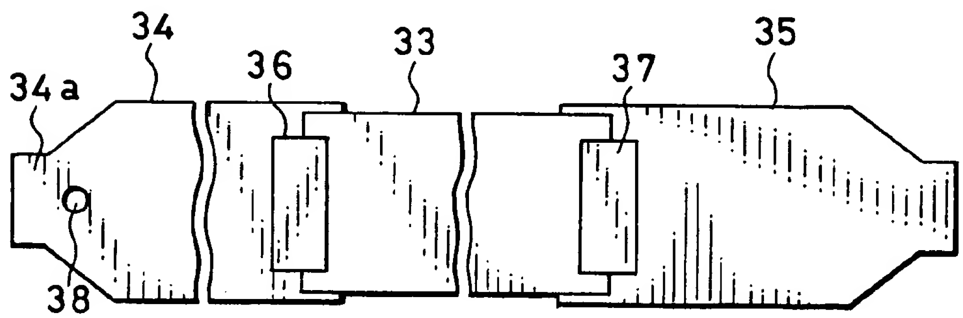


FIG. 12

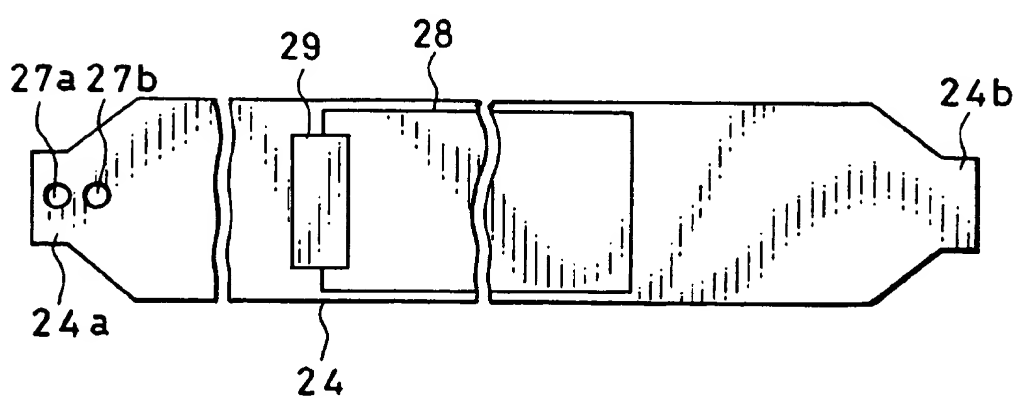


FIG. 3

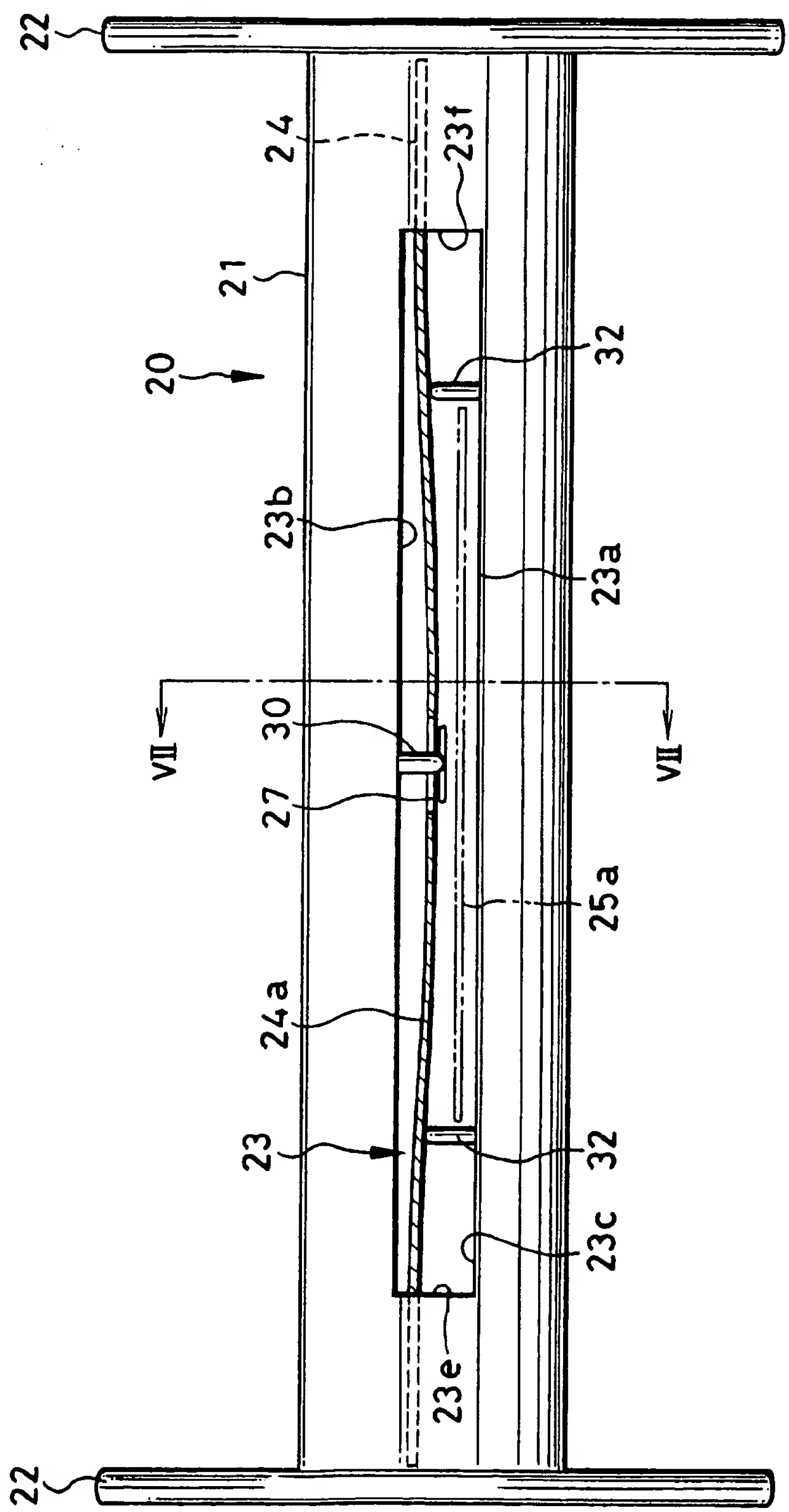


FIG. 4

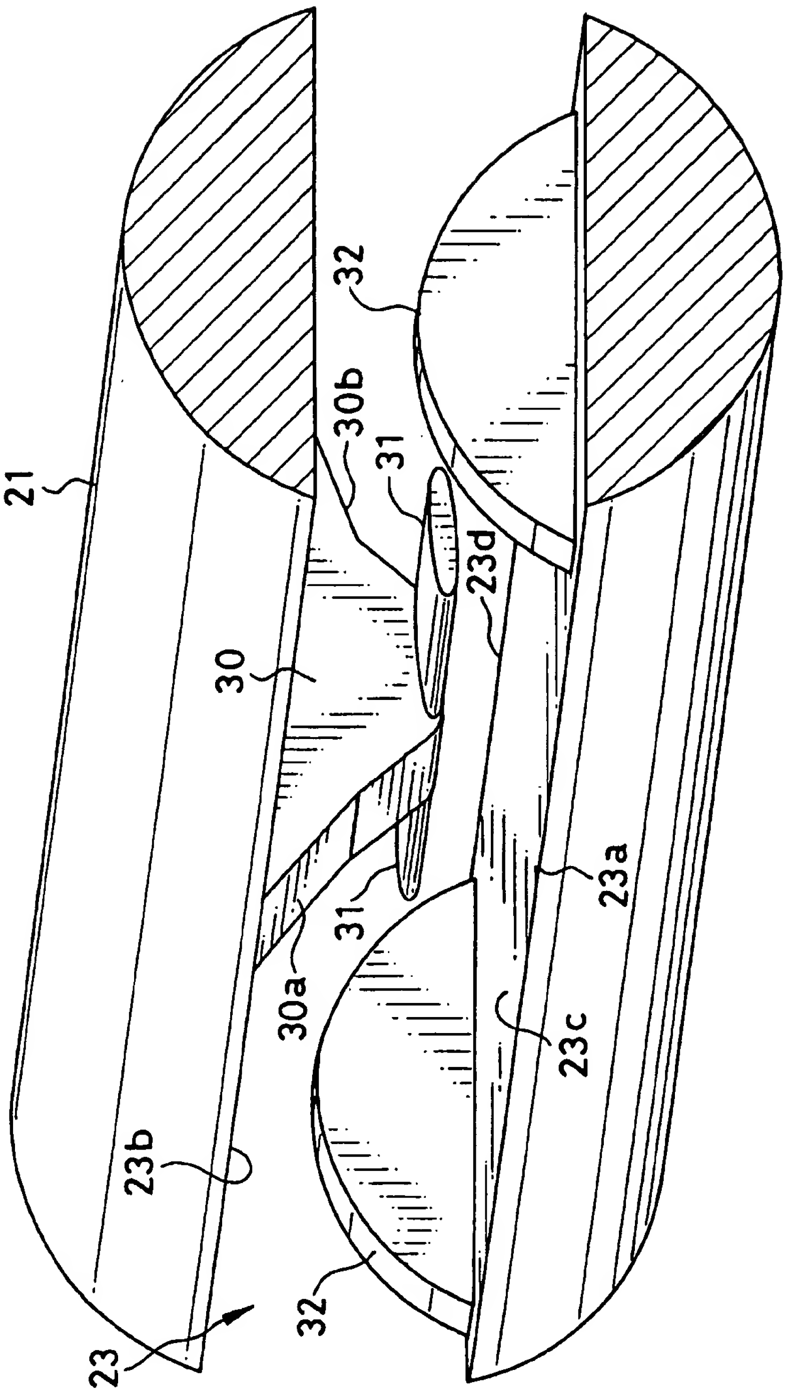


FIG. 5

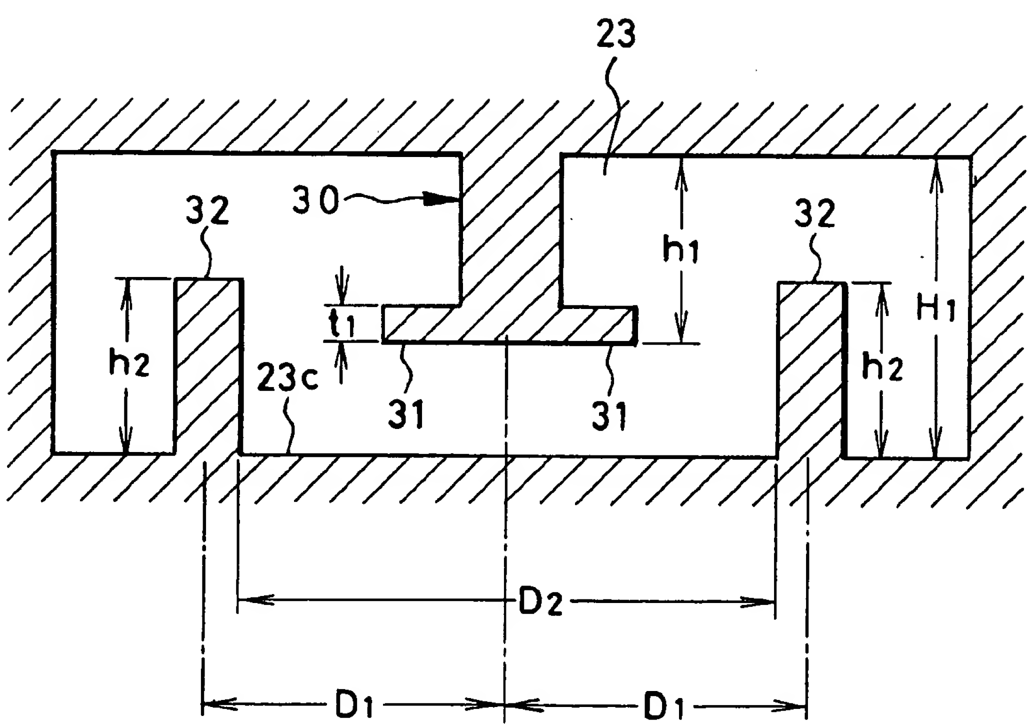


FIG. 6

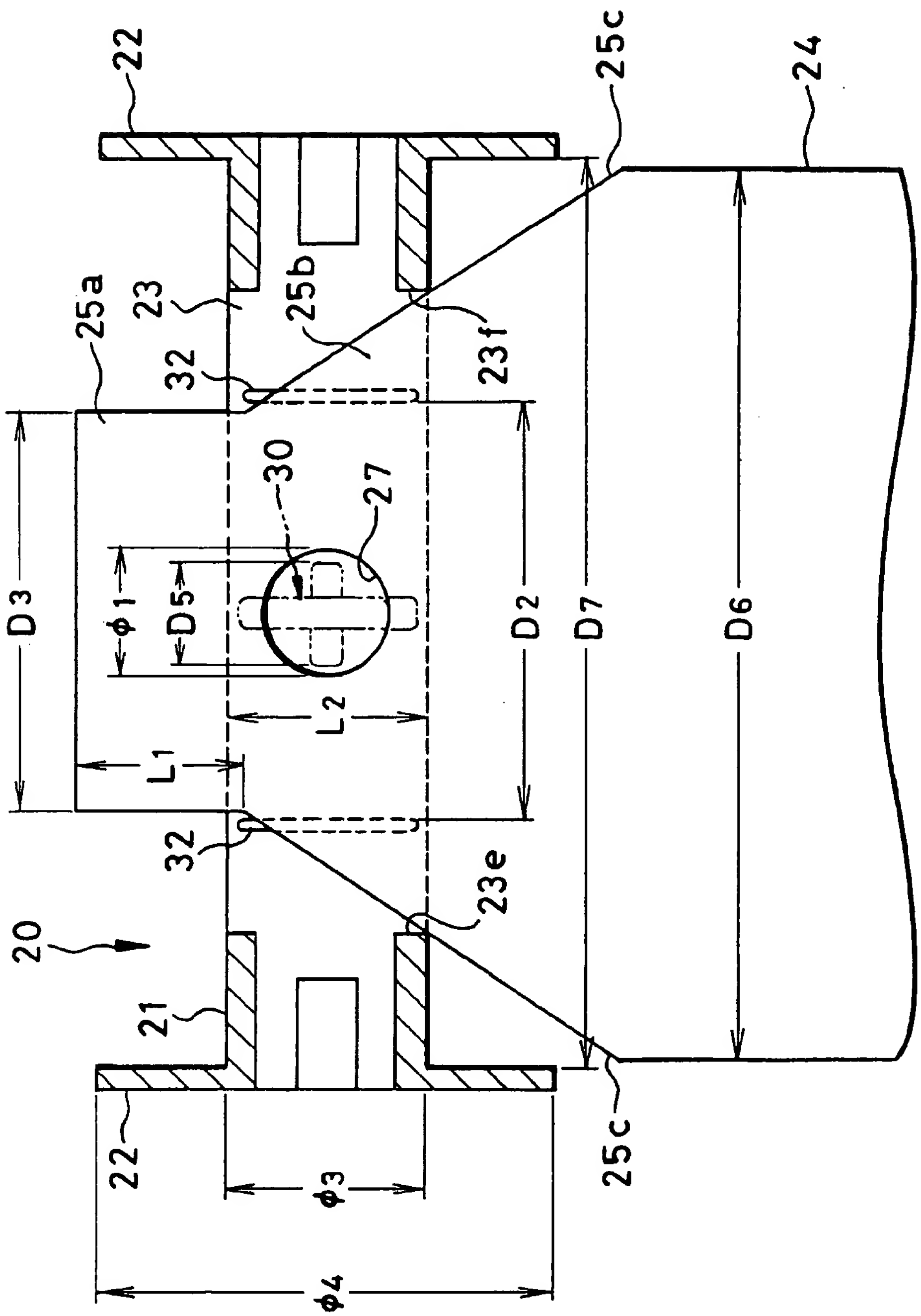

22
25c
24
25a
23
25b
32
23f
30
27
D3
φ1
D5
D2
D7
D6
L2
L1
32
23e
20
21
22
25c
φ3
φ4

FIG. 7

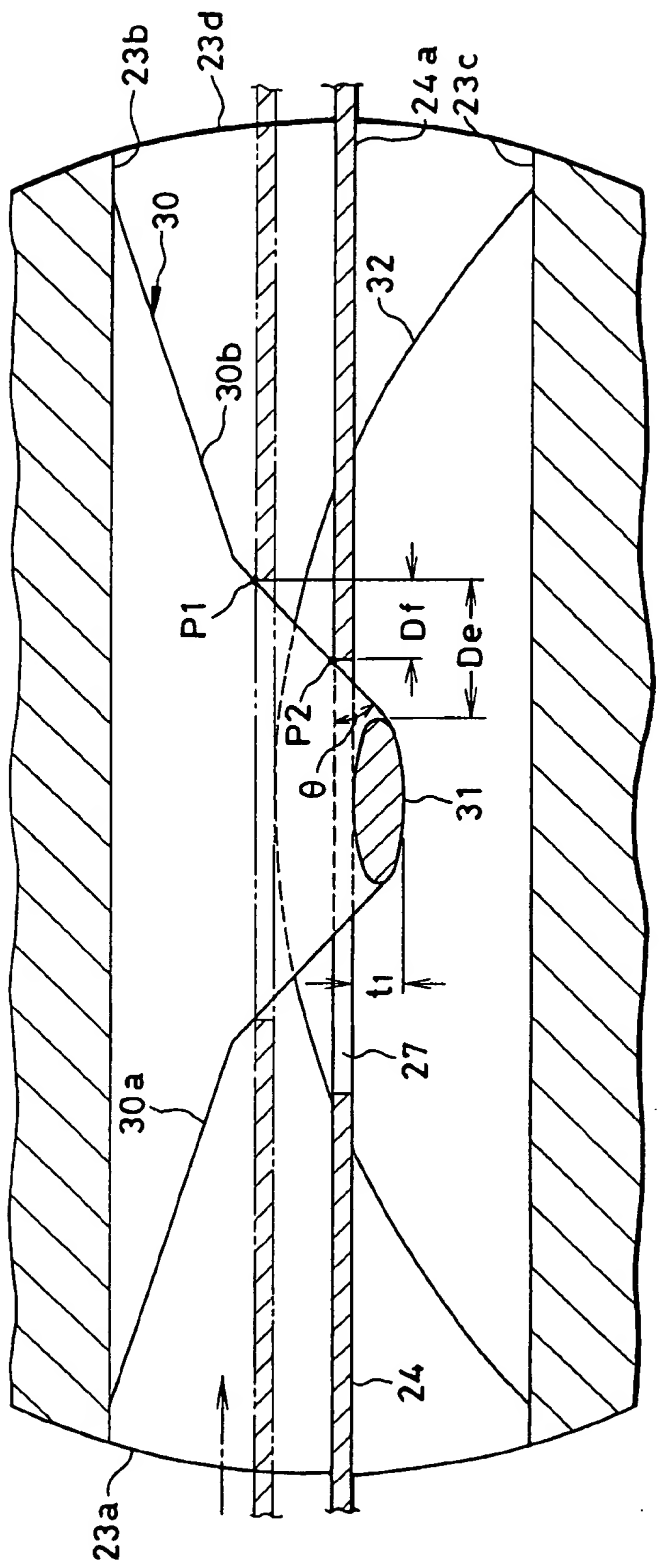


FIG. 8

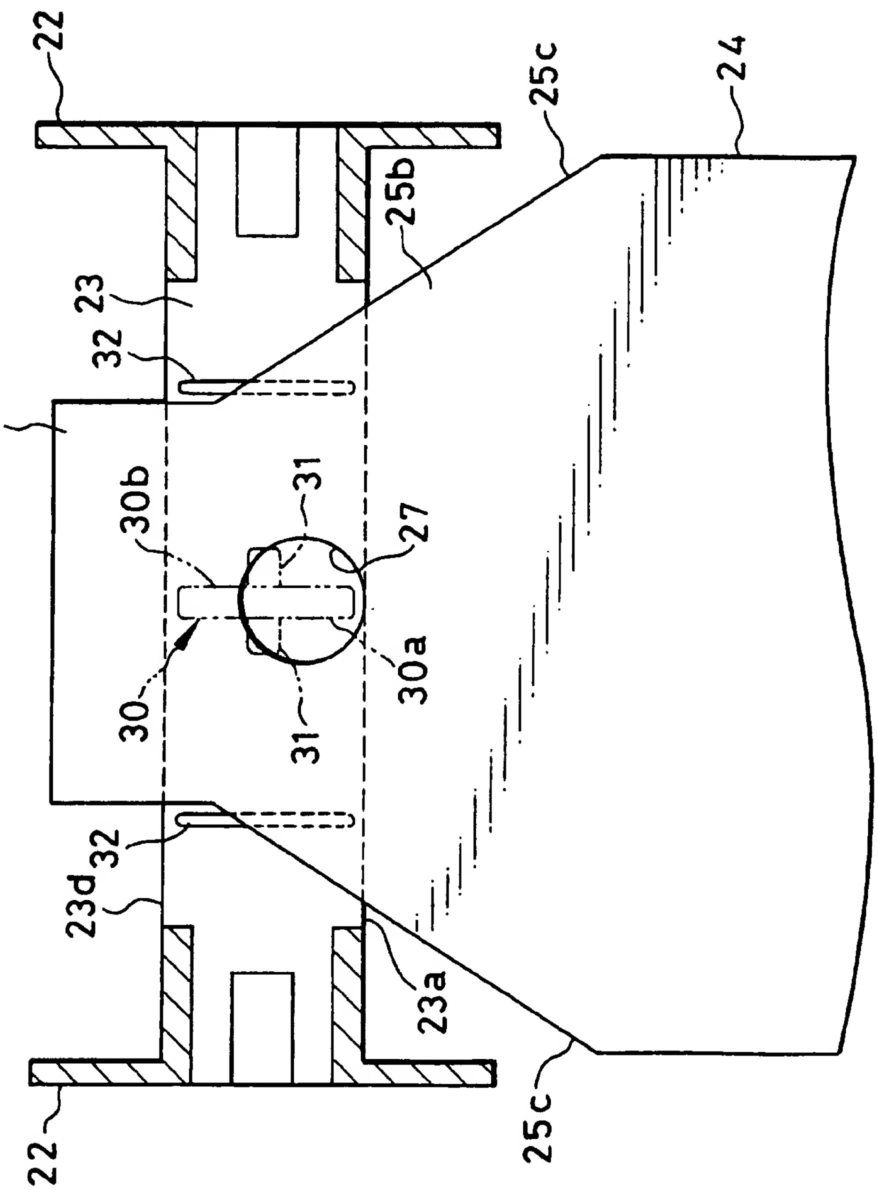


FIG. 9

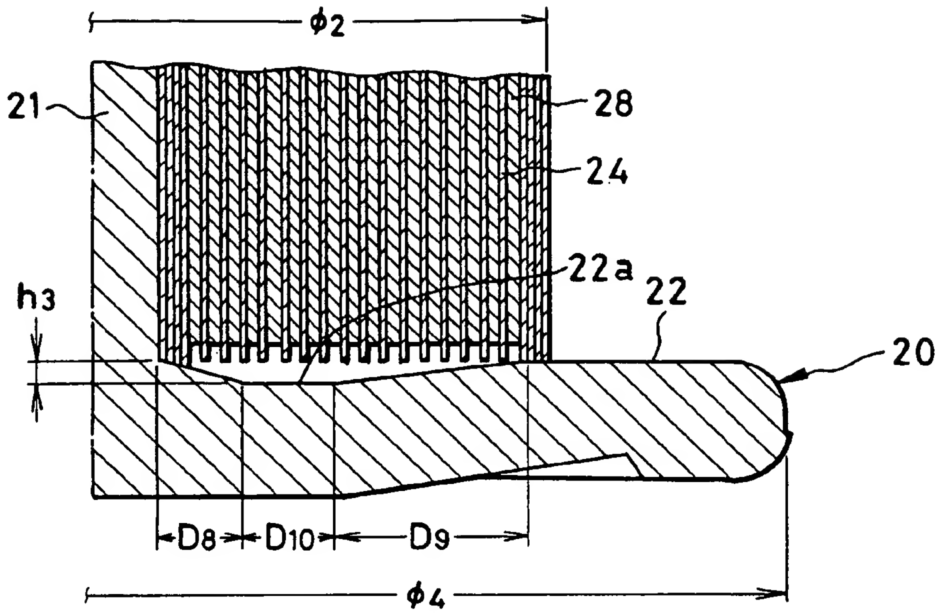


FIG. 11

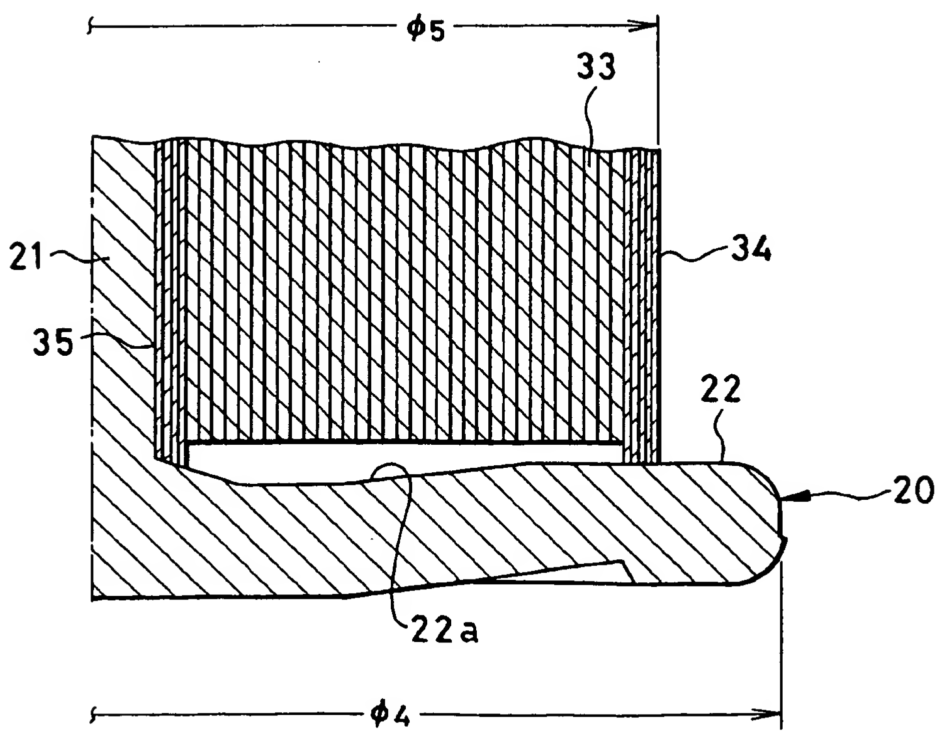


FIG. 13

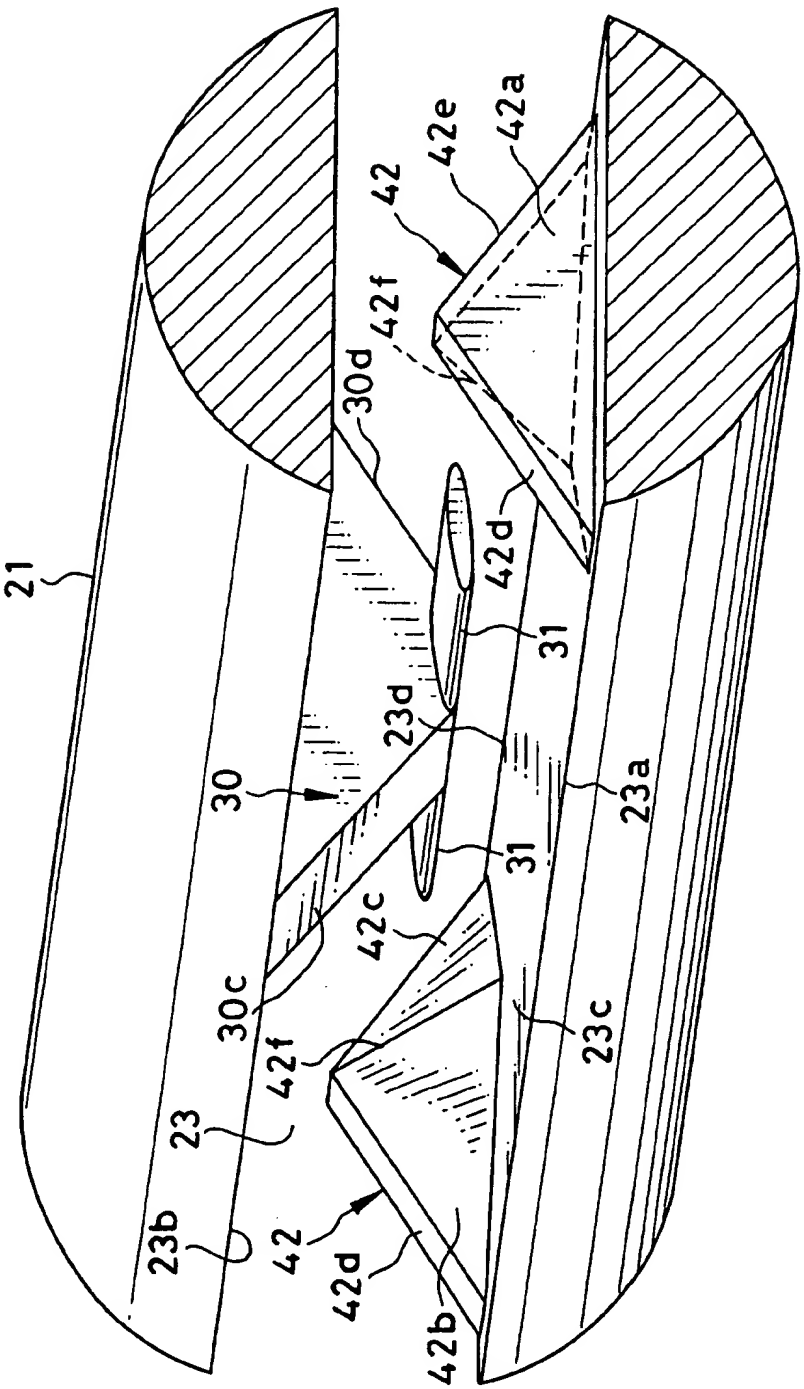

21
30d
42
42e
42a
42f
42d
31
23d
30
23a
31
42c
30c
42f
23c
23
23b
42
42d
42b

FIG. 14 A

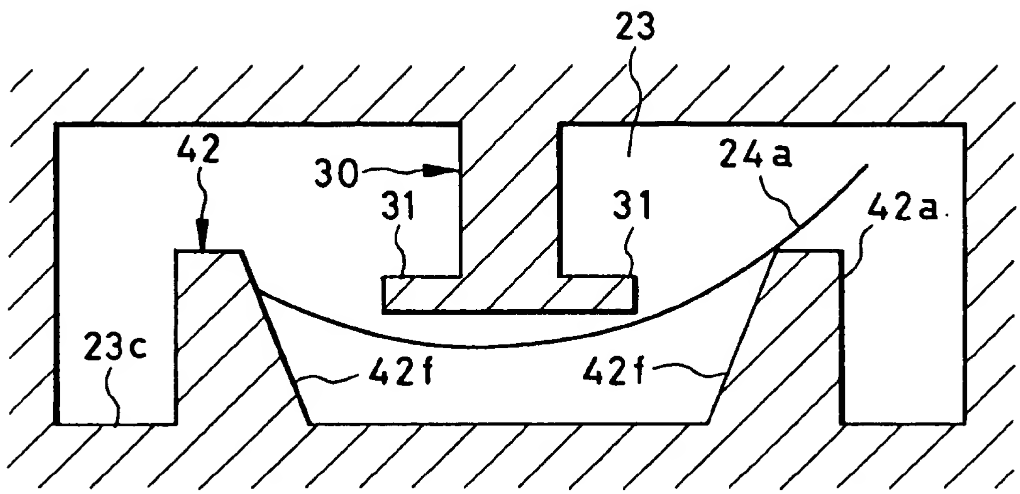


FIG. 14 B

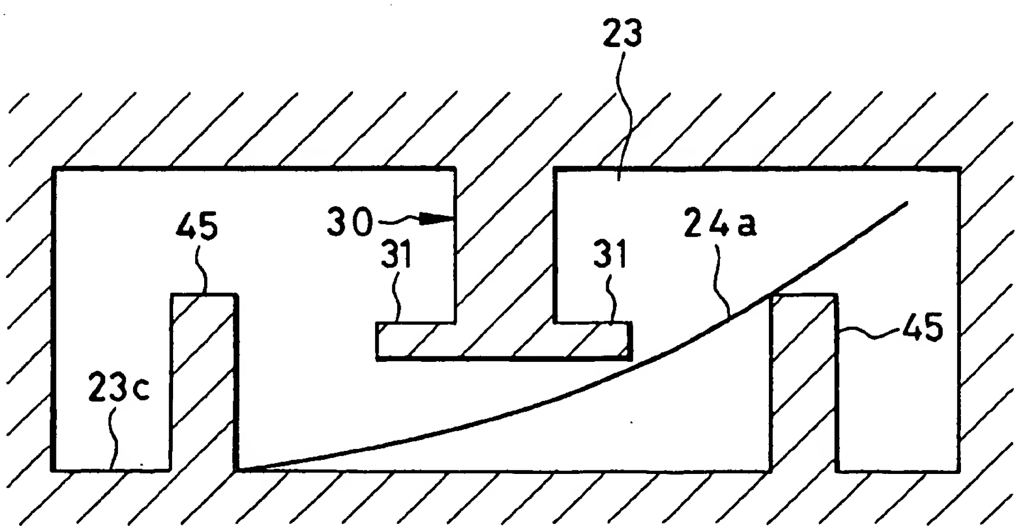


FIG. 15 A

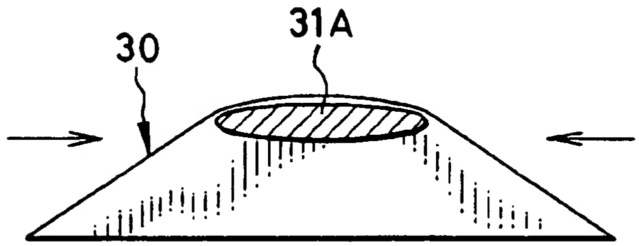


FIG. 15 B

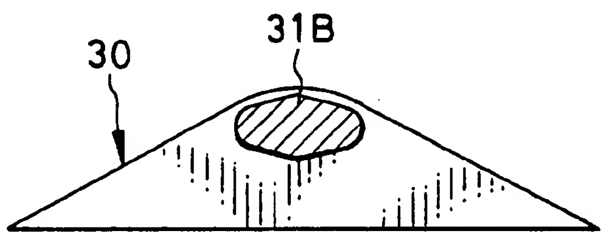


FIG. 15 C

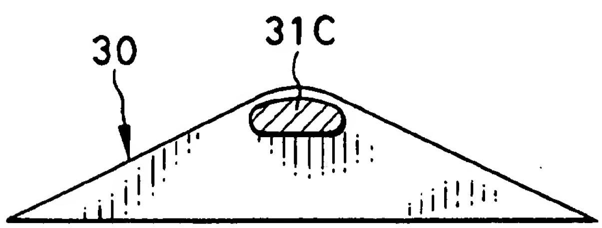


FIG. 15 D

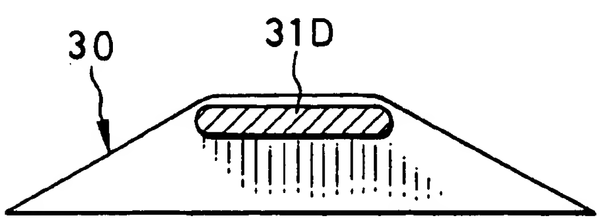


FIG. 16

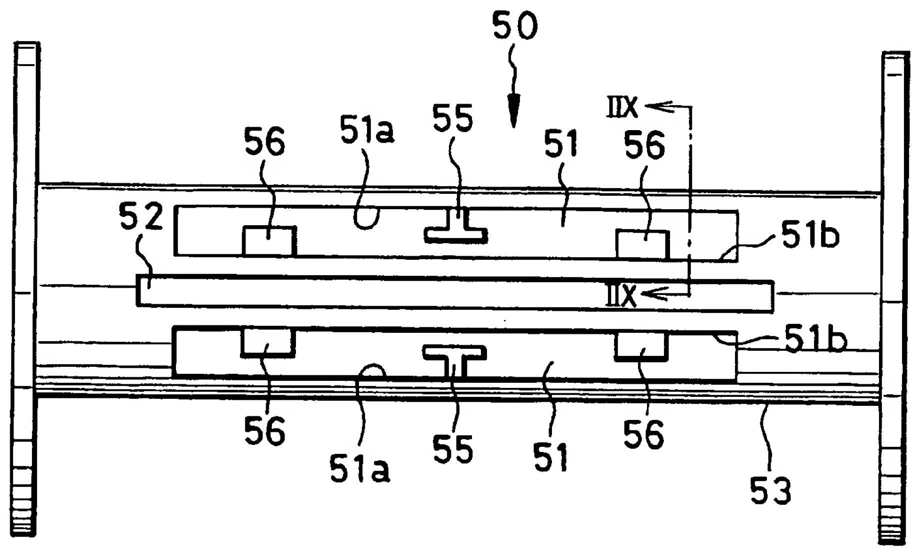

50
55
51a
56
51
56
IIX
52
51b
IIX
51b
56
55
51a
51
56
53

FIG. 17

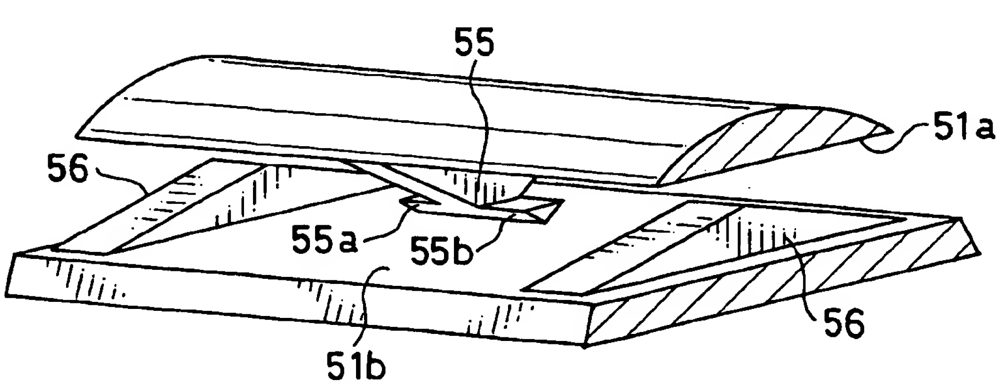

55
51a
56
55a
55b
51b
56

FIG. 18

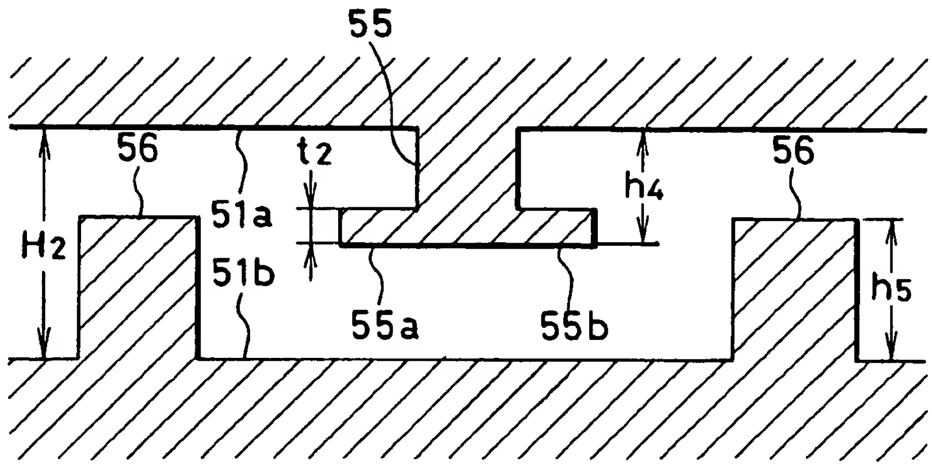

55
56
51a
t2
h4
56
H2
51b
55a
55b
h5

FIG. 19

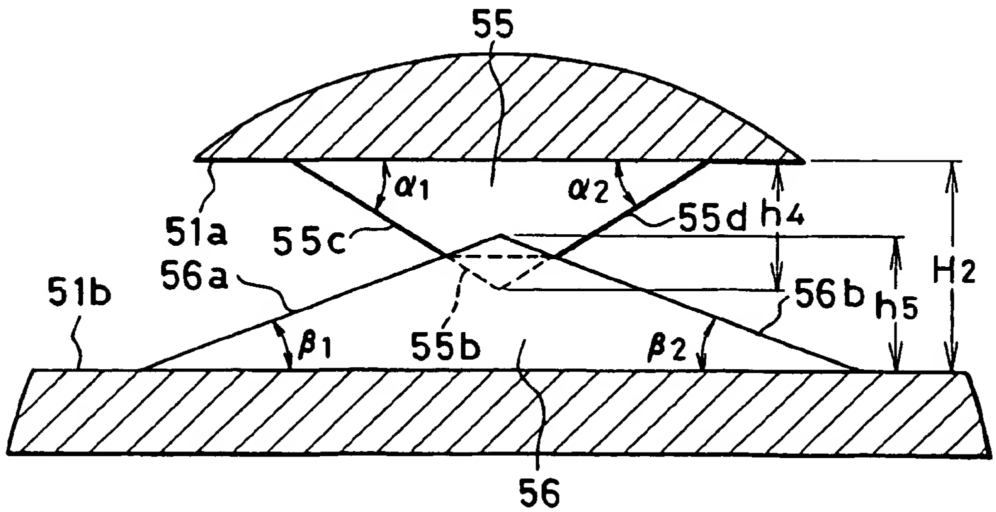

55
α1
α2
51a
55c
55d
h4
56a
51b
56b
H2
h5
β1
55b
β2
56

FIG. 20

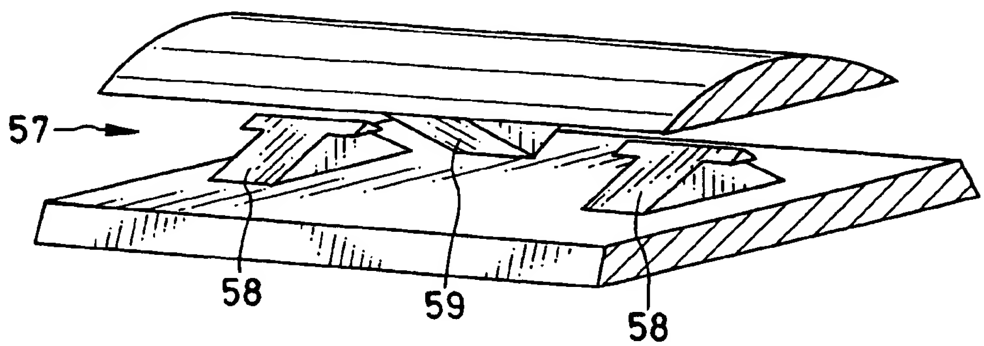


FIG. 21

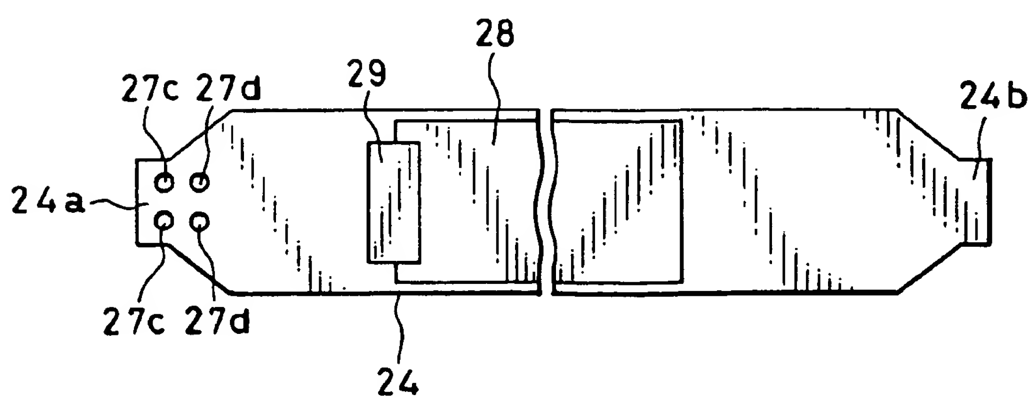


FIG. 22

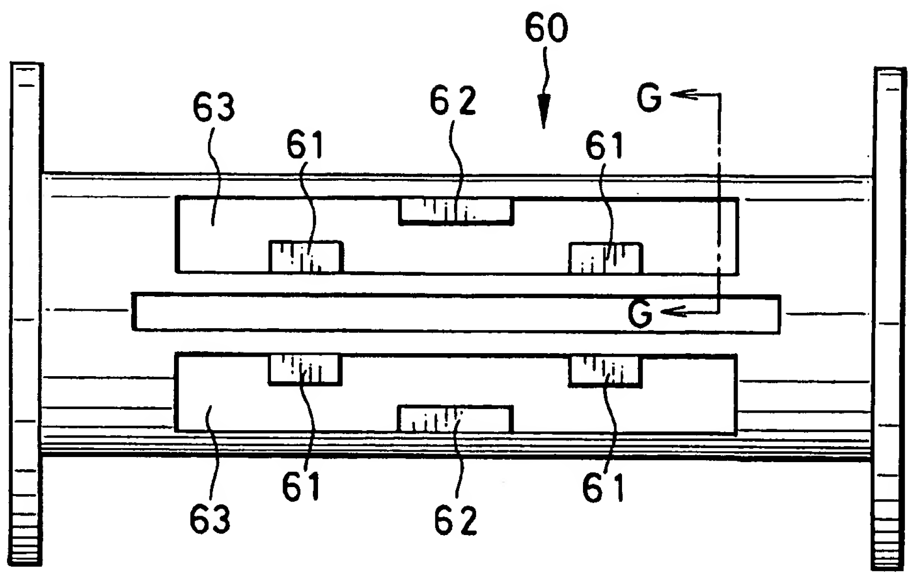


FIG. 23

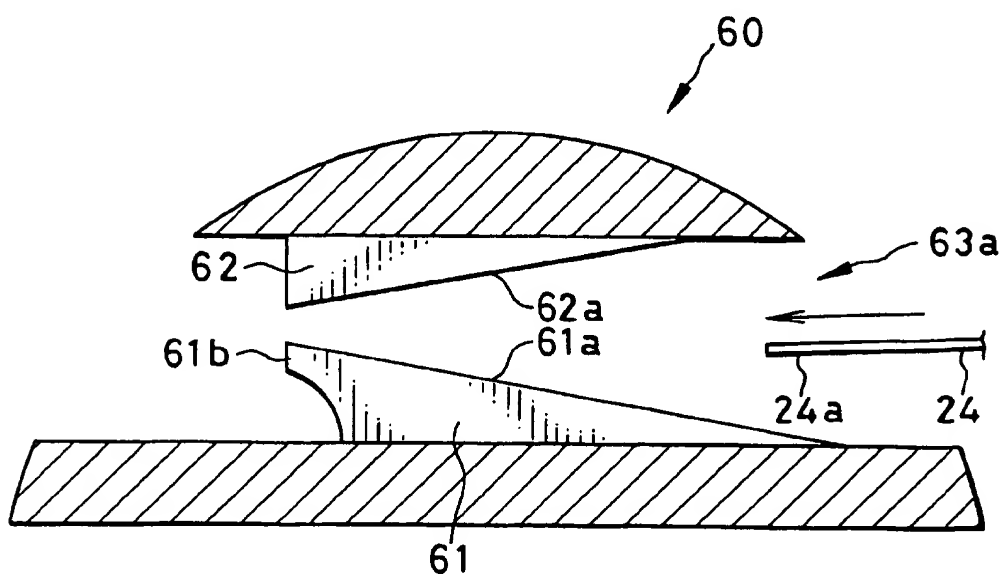


FIG. 24

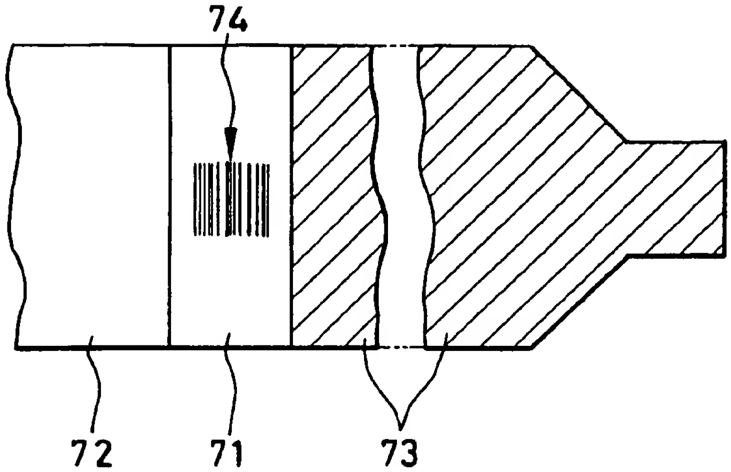


FIG. 25

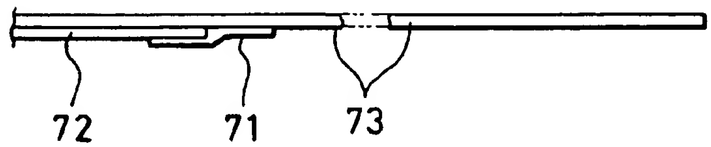


FIG. 26

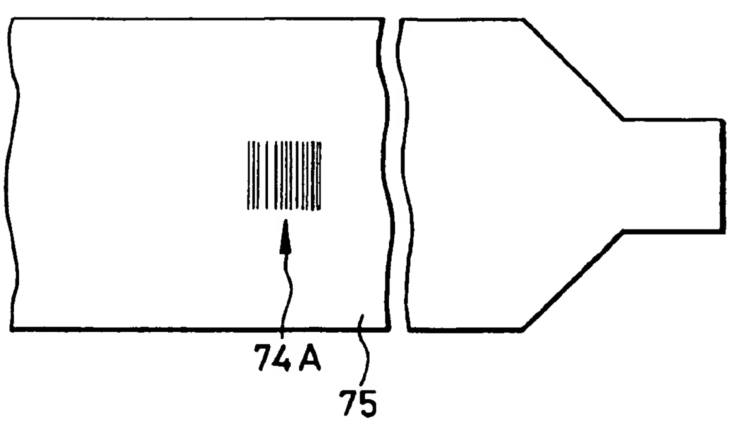


FIG. 27

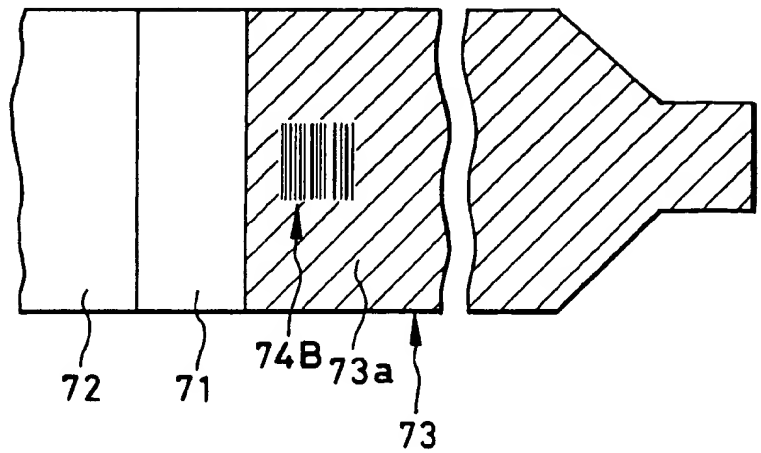


FIG. 28

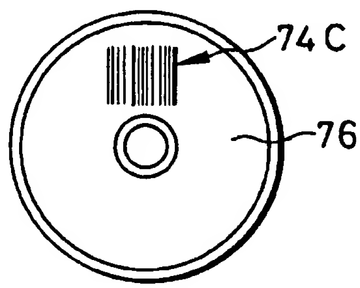


FIG. 29
(PRIOR ART)

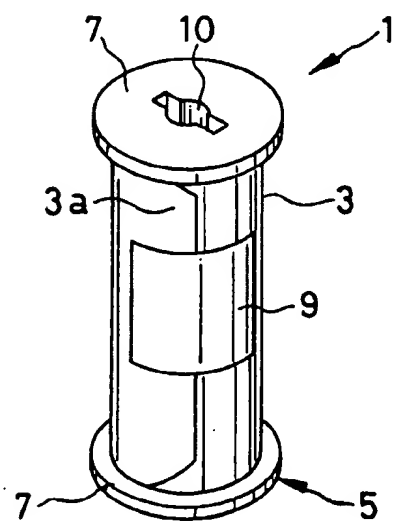


FIG. 30 (PRIOR ART)

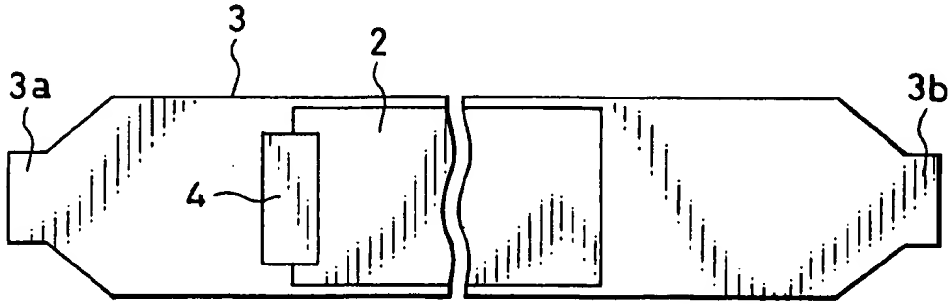


FIG. 31 (PRIOR ART)

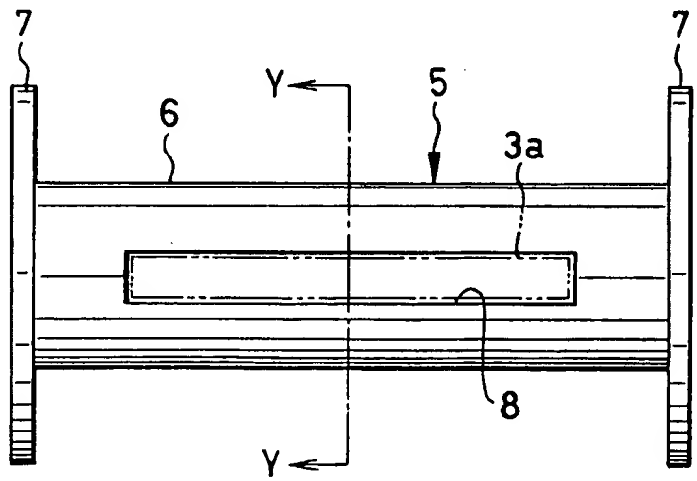
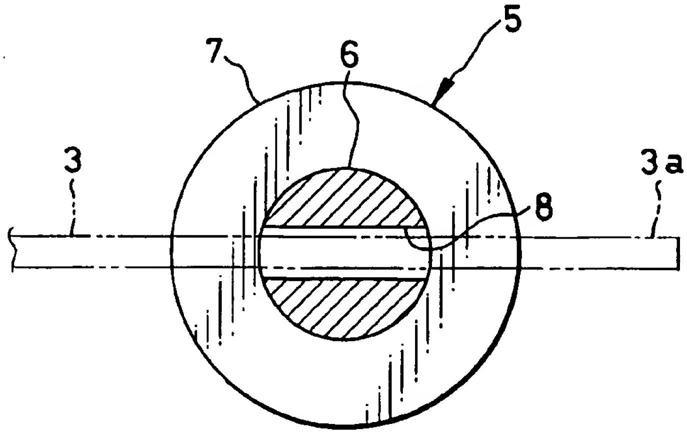


FIG. 32 (PRIOR ART)



PHOTOGRAPHIC ROLL FILM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a photographic roll film, especially 120-size or 220-size roll film.

2. Description of the Related Art

ISO 120-size and 220-size roll films are well known as Brownie film in the art which both have an appearance as shown in FIG. **29**. In a 120-size roll film **1**, a filmstrip **2** is secured to a light-shielding backing paper **3** which extends over the filmstrip **2**, as is shown in FIG. **30**. A 220-size roll film uses a longer filmstrip than 120-size, while a backing paper is replaced by a leader paper and a trailer paper which are secured to opposite ends of the elongated filmstrip. Thus, the 220-size roll film has a larger number of available exposure frames, compared with the 120-size. In both sizes, the filmstrip is coiled around a spool **5**.

The spool **5** is standardized according to ISO 732-1982, ANSI PHI 21-1980, JIS K7512-1985 etc., which is constituted of a spool core **6**, a pair of flanges **7** provided on opposite ends of the spool core **6**, and a slit **8** formed along the spool core **6**, as is shown in FIG. **31**. The flanges **7** confine and align edges of the backing paper **3** rolled on the spool core **6**.

To manufacture the roll film **1**, a trailer 3b is inserted in the slit **8**.

Then, the spool **5** is rotated to coil the filmstrip **2** with the backing paper **3** around the spool core **6**. Thereafter, a leading end **3***a* of the backing paper **3** is bent and is secured with an adhesive tape **9** to prevent unwinding. In a center of each end face of the flanges **7**, there is a chucking groove **10** to be engaged with a key shaft of a camera.

To load the roll film **1**, another spool having the same construction as the spool **5** should previously be positioned in a film take-up chamber of the camera. After opening a rear lid of the camera, the photographer first peals off the tape **9** while holding the backing paper **3** so as not to unwind. Then, the chucking grooves **10** are engaged with the key shafts of a film supply chamber of the camera.

The leader **3***a* is then inserted in the slit **8** of the spool **5** in the film take-up chamber, hereinafter referred to as a take-up spool, as is shown in FIGS. **31** and **32**. Then, a windup lever of the camera is operated to rotate the take-up spool **5** to wind the backing paper **3** around the spool core **6** of the take-up spool **5** more than one turn, usually two or three turns. When the leader **3***a* is thus secured to the take-up spool **5**, the rear lid is closed, and the windup lever is further operated to position the filmstrip **2** in an appropriate exposure position.

After each exposure, the windup lever is operated to wind up the exposed frame of the filmstrip **2** onto the take-up spool **5**. When all available frames have been exposed, the windup lever is allowed to be operated without stop, so that the entire length of the roll film **1** is wound up onto the take-up spool **5**. Thereafter, the rear lid is opened to remove the exposed roll film **1**. Then, the trailer **3***b*, which is now on the outermost convolution of the roll, is secured with an adhesive tape. The spool **5** left in the film supply chamber is replaced in the film take-up chamber for the next loading of an unexposed roll film.

However, because the leader **3***a* is apt to slip off the slit **8**, the photographer should hold the backing paper **3** so as not to slip off the slit **8** while operating the windup lever. This is obviously inconvenient. Moreover, if the leader **3***a* is

not properly wound on the spool **5**, e.g. if the leader **3***a* is deviated in the axial direction relative to the spool **5**, the deviation would increase with increasing number of turns, and the edge of the backing paper **3** is bent to loosen the roll on the spool **5**. As a result, light-tightness between the edges of the backing paper **3** and the flanges **7** is lowered so that the filmstrip **2** can be fogged.

Several solutions have been suggested to prevent the slip. For example, JPA 1-251030 provides protrusions in the slit to increase frictional resistance between the light-shielding paper or backing paper and the spool; JPA 2-235052 provides cutouts through the leader of the light-shielding paper, so as to be engaged with projections in the slit of the spool; JPA 2-137842 makes surface deformation treatment on either or both of contacting surfaces between the spool and the leader of the light-shielding paper, so as to be engage with each other; and JPA 2-160231 shapes the spool to have a particular edge angle between the spool core periphery and the inner surface of the slit.

However, any of the above known solutions do not completely prevent the slip-off of the leader so that it is still necessary to hold the leader to the slit of the spool with the fingers until the leader has been securely wound around the spool. Thus, none of these known spools achieve sufficiently easy and reliable loading and preliminary winding of the 120 or 220-size roll film.

On the other hand, there are various spools for 35 mm or ISO 135-size roll film that has claws in a slit to engage with holes of a film leader. U.S. Pat. No. 1,930,144 even suggests that the spool disclosed therein is applicable to those roll films which are attached with light-shielding paper. However, all of the spools suggested for 135-size roll film designate the direction to insert the film leader into the slit. Therefore, if such a spool could be used for 120 or 220-size roll film, it would be necessary to insert the leader of the light-shielding paper from the right direction into the slit of the spool placed in the film take-up chamber at every film loading. That would lower the efficiency of loading, and could cause improper preliminary winding. It has been difficult to automatize the loading and preliminary winding of the 120 or 220-size roll film.

SUMMARY OF THE INVENTION

It is a principal object of the present invention to provide a spool that permits easy and reliable loading and preliminary winding of the 120 or 220-size roll film, and hence permits automatic loading and preliminary winding of the 120 or 220-size roll film.

To achieve the above object and other advantages in a photographic roll film having a photographic filmstrip, a light-shielding paper secured to the photographic filmstrip at least at a leading end thereof, and a spool having the photographic filmstrip with the light-shielding paper wound in a roll thereon, according to the present invention, the photographic roll film comprising: at least a hole formed through a leader of the light-shielding paper; a slit formed through a spool core of the spool along an axial direction of the spool core; and at least a claw formed on a first wall of the slit, the claw being engaged with the hole when the leader is inserted in the slit; and at least a rib formed on an opposite parallel wall of the slit to the first wall, the rib pressing the leader of the light-shielding paper toward the first wall.

According to a preferred embodiment, the rib has a height from the opposite wall, which is larger than a thickness of the light-shielding paper plus a distance from a peak of the claw to the opposite wall.

According to another preferred embodiment, the claw has side projections in proximity to the peak, the projections extending in the axial direction of the spool core.

According to a further preferred embodiment, the claw and rib are individually symmetrical about a plane extending through an axial center of the spool core and perpendicularly to the walls of the slit, and guide surfaces of the claw and rib which face open sides of the slit are inclined relative to the walls to taper off to respective peaks, and wherein the guide surfaces of the claw have an inclination angle θ at least in portions proximate the side projections, the inclination angle θ being defined as follows:

$$\tan\theta \geqq t1/(De-Df)$$

wherein

- t1 is a thickness of the side projection;
- De is a distance between forward edges of the side projections and an initial contact point of a rim of the hole with a forward one of the guide surfaces of the claw with respect to an inserting direction of the light-shielding paper into the slit; and
- Df is a distance between the initial contact point and a final contact point of the rim with the forward guide surface of the claw, where the hole is engaged with the side projections.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent upon reading the detailed description of the embodiments in connection with the accompanying drawings, wherein like reference numerals designate like or equivalent parts throughout the several views, and wherein:

FIG. 1 is a perspective view illustrating an automatic insertion of a leader of a light-shielding paper of a film into a slit of a spool according to a first embodiment of the invention;

FIG. 2 is a plan view of a 120-size film having a hole formed through the leader, according to the first embodiment of the invention;

FIG. 3 is a front view of the spool with the hole of the leader engaged with a claw of the spool;

FIG. 4 is an enlarged perspective view showing the claw and ribs formed in the slit of the spool according to the first embodiment of the invention;

FIG. 5 is an explanatory view illustrating dimensions of the claw and the ribs in the slit of the first embodiment;

FIG. 6 is an explanatory sectional view taken along the axial direction of the spool of the first embodiment, illustrating the relationship between the claw and the hole of the leader of the film;

FIG. 7 is an enlarged sectional view taken along a line VII—VII of FIG. 3, illustrating a position where the hole is engaged with side projections of the claw;

FIG. 8 is an explanatory sectional view taken along the axial direction of the spool, illustrating the same position as shown in FIG. 7;

FIG. 9 is a fragmentary sectional view of the spool with the 120-size film wound entirely thereon;

FIG. 10 is a plan view of a 220-size film having a hole formed through a leading paper thereof, according to an embodiment of the invention;

FIG. 11 is a fragmentary sectional view of the same spool as shown in FIG. 9, but with the 220-size film wound entirely thereon;

FIG. 12 is a plan view of a 120-size film having two holes formed through a leader of a light-shielding paper, according to another embodiment of the invention;

FIG. 13 is a perspective view illustrating essential parts of a spool according to a second embodiment of the invention;

FIGS. 14A and 14B are explanatory views illustrating an advantage of the spool of the second embodiment;

FIGS. 15A, 15B, 15C & 15D are views illustrating various modifications of sectional contours of side projections;

FIG. 16 is a front view of a spool having two slits according to a third embodiment of the invention;

FIG. 17 is an enlarged view illustrating a claw and ribs formed in each slit of the spool of FIG. 16;

FIG. 18 is an explanatory view illustrating dimensions of the claw and ribs of the spool of the third embodiment shown in FIG. 16;

FIG. 19 is a sectional view taken along a IIX—IIX of FIG. 16;

FIG. 20 is a view similar to FIG. 17, but showing another embodiment of the invention wherein a pair of claws and a rib are formed in a slit of a spool;

FIG. 21 is a plan view of a 120-size film for use with the spool of FIG. 20;

FIG. 22 is a front view of a spool according to a fourth embodiment of the invention;

FIG. 23 is a sectional view taken along a line G—G of FIG. 22;

FIG. 24 is a plan view, partly cut away, of a leader of a 120-size film with a bar code, according to an embodiment of the invention;

FIG. 25 is a side view of the film shown in FIG. 24;

FIG. 26 is a plan view, partly cut away, of a leader of a 120-size film with a bar code, according to another embodiment of the invention;

FIG. 27 is a plan view, partly cut away, of a leader of a 120-size film with a bar code, according to another embodiment of the invention;

FIG. 28 is a view illustrating an end face of a flange of a spool with a bar code;

FIG. 29 is a perspective view of a roll film relating to the invention;

FIG. 30 is a plan view of a standard 120-size film;

FIG. 31 is a front view of a conventional spool; and

FIG. 32 is a sectional view taken along a line Y—Y of FIG. 31.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In FIG. 1, a spool 20 according to the invention is constituted of a spool core 21, and a pair of flanges 22 formed on opposite ends of the spool core 21. A slit 23 is formed through an axial center of the spool core 21 along the axial direction thereof. A leader 24*a* of a light-shielding paper 24 which backs a filmstrip 28 in a 120-size is to be inserted in the slit 23. The leader 24*a* has a narrower tip 25*a* and a trapezoidal portion 25*b* whose edges 25*c* are tapered to the tip 25*a*, as shown in FIG. 2.

In a center of each flange 22 is formed a chucking groove 26 to be engaged with a key shaft which is provided in each of a film supply chamber and a film take-up chamber of a camera. The chucking groove 26 may have a plus shape. But it is preferable to make the chucking groove 26 have a minus

shape extending in the same radial direction as the slit **23**, as is shown in FIG. **1**, because it facilitates positioning the slit **23** in a proper angular position in the film supply or the film take-up chamber. This configuration is preferable especially for automatic film loading. A round hole **27** is formed through the light-shielding paper **24** at the trapezoidal portion **25***b* of the leader **24***a*. In FIG. **1**, reference numbers **15** and **16** designate a guide roller and a drive roller of the camera, respectively.

As shown in FIG. **2**, the filmstrip **28** of the 120-size is secured at its leader to the light-shielding paper **24** with an adhesive tape **29**, and the light-shielding paper **24** backs and extends beyond the entire length of the filmstrip **28**. When rolled around the spool core **21** of the spool **20**, the photosensitive emulsion surface of the filmstrip **28** faces inward.

A trailer **24***b* of the light-shielding paper **24** has no hole for engagement with the spool **20**. When the 120-size roll film according to the invention is manufactured, the trailer **24***b* is inserted in the slit **23** for winding the unexposed filmstrip **28**. Therefore, the trailer **24***b* can smoothly move out of the slit **23** to wind up onto the other spool **23** that is previously positioned in the film take-up chamber after the completion of exposure of all available frames.

As shown in FIG. **3**, a claw **30** is formed on one wall **23***b* of the slit **23** in a middle position there of, while a pair of ribs **32** are formed on an opposite wall **23***c* of the slit **23**. The walls **23***b* and **23***c* are parallel to each other. The claw **30** is to engage with the hole **27** of the leader **24***a* of the light-shielding paper **24**. The ribs **32** are to press the leader **24***a* toward the claw **30** on opposite lateral sides of the hole **27** with respect to the inserting direction, so as to secure the engagement between the hole **27** and the claw **30**. The ribs **32** are spaced equally from the claw **30** in the axial direction of the spool core **21**. The claw **30** itself is symmetrical about a radial surface of the spool core **21**.

As shown in FIG. **4**, the ribs **32** and the claw **30** are also symmetrical about a surface which extends through the axial center of the spool core **21** and perpendicularly to the walls **23***b* and **23***c*. Therefore, the leader **24***a* may be equally inserted in the slit **23** from either open side **23***a* or **23***d* of the slit **23**. The claw **30** has guide surfaces **30***a* and **30***b*, which are inclined toward each other with two different inclination angles each. The guide surfaces **30***a* and **30***b* face the open sides **23***a* and **23***d* of the slit **23** to guide the narrower tip **25***a* of the leader **24***a* to a tip of the claw **30**. In proximity to the tip of the claw **30**, side projections **31** protrude from both lateral sides of the claw **30** with respect to the leader inserting direction. The side projections **31** extend in the axial direction of the spool core **21** in parallel to the walls **23***b* and **23***c* of the slit **23**. Because the side projections **31** are spaced from the tip of the claw **30**, the side projections **31** do not hinder the narrow tip **25***a* from passing over the tip of the claw **30**. The shape of each side projection **31** is approximately planar but is gently curved to round those edges which face the open sides **23***a* and **23***d* of the slit **23**. So the side projections **31** will not hinder the insertion of the leader **24***a* of the light-shielding paper **24**.

The ribs **32** have a symmetrical semi-circular shape and extend in the radial direction of the spool core **21**, so as to permit guiding the leader **24***a* toward the claw **30** from either open side **23***a* or **23***d* of the slit **23**. This configuration of the ribs **32** also permits smooth insertion of the trailer **24***b* of the light-shielding paper **24** or a leader or a trailer of a conventional light-shielding paper into the slit **23**. Accordingly, the spool **20** according to the invention may be used with a conventional 120-size or 220-size film.

Referring to FIG. **5**, provided that the claw **30** has a height **h1** from the wall **23***b*, that the ribs **32** have a height **h2** from the wall **23***c*, that the side projections **31** have a thickness **t1**, and that the slit **23** has a width **H1**, i.e., a distance between the walls **23***b* and **23***c*, it is preferable to satisfy a condition: $H1+t1<h1+h2<2\cdot H1$. Under this condition, the ribs **32** can push the leader **24***a* of the light-shielding paper **24** toward the claw **30** to ensure the engagement of the claw **30** in the hole **27**.

In particular, H1 is most preferably 1.8 mm to 3.0 mm, whereas h1+h2 is most preferably H1+t1+(0.1 mm to 0.5 mm). In other words, it is most preferable that the claw **30** and the ribs **32** overlap each other in the width direction of the slit **23** by an amount t1+(0.1 mm to 0.5 mm). A distance D1 between the centers of the claw **30** and the rib **32** in the axial direction of the spool core **21** must be adjusted according to the stiffness and the shape of the leader **24***a*, but a preferable range of D1 is 5 mm to 20 mm, and more preferably from 7 mm to 17 mm. Without the side projections **31**, it is possible to define that h1+h2+(thickness of the light-shielding paper **24**)>H1, but h1+h2>H1 is preferable. According to this configuration, the light-shielding paper **24** would always be brought into contact with the claw **30** when inserted into the slit **23**, to ensure the engagement between the claw **30** and the hole **27**.

The ribs **32** are spaced from each other by a distance D2 which is more than a width D3 of the leader **24***a* in the narrow tip **25***a*, as shown in FIG. **6**. The narrow tip **25***a* has a length L1 in the inserting direction, which is more than half a length L2 of the slit **23** in the inserting direction. According to this configuration, as the leader **24***a* is being inserted into the slit **23**, the narrow tip **25***a* is guided at its lateral edges along the ribs **32** for a certain time, as is shown by phantom lines in FIG. **3**. Therefore, the light-shielding paper **24** is inserted straight into the slit **23** perpendicularly to the axial direction of the spool core **21**. While the leader **24***a* is being further inserted through the slit **23**, the leader **24** is centered with the center of the slit **23** in the axial direction of the spool core **21**. Further insertion makes the tapered edges **25***c* of the trapezoidal portion **25***b* ride on the ribs **32**, as shown in FIG. **6**.

The hole **27** is disposed such that the center of the hole **27** is opposed to the center of the claw **30** when the leader **24***a* is stopped from further insertion into the slit **23** when the tapered edges **25***c* of the trapezoidal portion **25***b* come into contact with side margins **23***e* and **23***f* of the slit **23**. Therefore, the hole **27** is automatically caught on the claw **30** upon a predetermined amount of insertion of the leader **24** into the slit **23**. This facilitates automatic film loading. The diameter $\phi1$ of the hole **27** is determined to be 0.5 mm to 1.0 mm more than a distance D5 between distal ends of the side projections **31**. Therefore, the hole **27** can be reliably caught on the claw **30** just by inserting the leader **24***a* into the slit **23**. Once the hole **27** is engaged with the claw **27**, the leader **24** is moved upward or toward the claw **30** under the pressure of the ribs **32**, until the rim of the hole **27** comes into contact with the guide surfaces **30***a* and **30***b* of the claw **30**, as shown by phantom lines in FIG. **7**. The contact point of the hole **27** with the guide surface **30***b* in this position will be referred to as an initial contact point **P1**. Thereafter when the spool **20** is rotated in a winding direction, the light-shielding paper **24** relatively moves in a direction to slip off the slit **23**. But then, since the hole **27** is moved past the side projections **31**, the rim of the hole **27** is guided along the guide surface **30***b*, and hooked on the side projections **31**, as is shown in FIG. **8**. The side projections **31** thus secure the engagement between the claw **30** and the

leader 24a. As shown, the guide surfaces 30a and 30b of the claw 30 have a shallow angle of inclination with respect to the slit walls in base portions near the wall 23b and a steeper angle of inclination in the peak portion near the tip of the claw where side projections 31 are attached.

In order to allow the hole 27 to be automatically engaged with the side projections 31 in the way as above, it is necessary to define the steeper inclination angle θ of the guide surface 30b relative to the walls 23b and 23c of the slit as follows:

$$\tan\theta \geqq r1/(De-Df)$$

wherein

- Df represents a distance in the inserting direction between the initial contact point P1 and a final contact point P2 of the rim of the hole 27 with the guide surface 30b where the hole 27 is engaged with the side projections 31; and
- De represents a distance in the inserting direction between the initial contact point P1 and the edges of the side projections 31.

If the values θ, De and Df do not satisfy the above relationship, the hole 27 will not catch on the side projections 31 when the spool 20 is rotated after the hole 27 is engaged with the claw 30.

To ensure the light-tightness between the flanges 22 and the light-shielding paper 24, the width D6 of the light-shielding paper 24 is designed to be equal to or slightly more than the distance D7 between the inside surfaces of the flanges 22 at a peripheral position thereof. For example, D6=62.70 mm to 62.85 mm, and D7=62.70 mm±0.1 mm measured at 1.0 mm to 1.5 mm from the rims of the flanges.

If the width D6 is too large relative to the distance D7, or the width D6 has variations, it is impossible to tightly wind the light-shielding paper 24, so that the diameter ϕ2 of the roll coiled around the spool core 21 would be enlarged. To prevent this problem, an annular recess 22a with a depth h3 is formed in the inside surface of each flange 22 coaxially around the spool core 21, as shown in FIG. 9. The recesses 22a prevents the edges of the light-shielding paper 24 from bending and folding into the roll, and thus from enlarging the diameter ϕ2 of the roll. Accordingly, the edges of the light-shielding paper 24 come into tight contact with the inside surfaces of the flanges 22 in the trailer 24b which forms the outermost convolution of the roll, while being prevented from bending in the inner convolutions. So the filmstrip 28 is completely shielded from ambient light.

The depth h3 of the recesses 22a is 0.15 mm to 0.30 mm, and preferably 0.20 mm to 0.25 mm. The recesses 22a have an approximately trapezoidal sectional contour, wherein the widths D8 and D9 of the inclined surfaces are to be as small as possible. In view of the moldability, the widths D8 and D9 are 0.8 mm to 1.0 mm, but should be adjusted according to the depth h3. The width D10 of the bottom surface of the recess 22a is 1.0 mm to 3.0 mm, and preferably 1.5 mm to 2.0 mm. It is useful to round the borders between the inclined surfaces and the bottom surface of the recess 22a for preventing molding failure. The diameter ϕ3 of the spool core 21 is 11.8 mm to 12.0 mm, and the external diameter ϕ4 of the flanges 22 is preferably 25.2 mm −0.2 mm to +0.1 mm.

Referring to FIG. 10 showing a 220-size film for use in a roll film of the invention, a filmstrip 33 is attached at its leading and trailing ends to light-shielding papers called leader 34 and trailer 35, by means of adhesive tapes 36 and 37. As the filmstrip 33 is not backed with a light-shielding

paper, the filmstrip 33 may be double the length of the filmstrip 28 of the 120-size and so the number of available frames, while maintaining the diameter ϕ5 of the roll on the spool 20 sufficiently within the external diameter ϕ4 of the flanges 22, as is shown in FIG. 11. Also in the 220-size, even if the filmstrip 33 has a small variation in width or if the leader 34 is slightly deviated or crooked, the recesses 22a prevents the edges of the filmstrip 33 from bending and thus prevents enlarging the diameter ϕ5 of the roll, in the same way as in the 120-size. The light-shielding papers 34 and 35 preferably have the same width D6 as the light-shielding paper 24, so that the edges of the papers 34 and 35 come into tight contact with the inside surfaces of the flanges 22, providing reliable light-shielding effect on the filmstrip 33. According to the embodiment shown in FIG. 10, the leader 34 of the 220-size film has a hole 38 and a narrow tip 34a in the same way as the 120-size film shown in FIG. 2.

When positioning the spool 20 having the above described construction in the film take-up chamber of the camera, the chucking groove 26 is engaged with the key shaft of the film take-up chamber. Since the chucking groove 26 extends in the same radial direction as the slit 23, it is possible to determine the angular position of the entrances 23a and 23d of the slit 23 with reference to the rotational angle of the key shaft. Therefore, one of the entrances 23a and 23d is oriented toward the guide roller 15 and the drive rollers 16 of the camera by means of a control device of the camera, so that the entrance 23a or 23d may smoothly accept the leader 24a or 34. Because the 120-size and 220-size roll film of the present invention operate equivalently, the operation will be described below with respect to the 120-size roll film for instance.

After the film roll is loaded in the film supply chamber of the camera, the leader 24a is placed on the drive roller 16, and the rear lid is closed to nip the leader 24a between the drive roller and a roller or a plate spring provided on the inside of the rear lid. Then, a motor is driven to rotate the drive roller to feed the leader 24a into the slit 23 through the guide roller and the entrance 23a.

When the edges 25c of the trapezoidal portion 25b of the leader 24a stop against the side margins 23e and 23f of the slit 23, the load on the drive roller 16 jumps up. A control device of the camera detects the change in load on the drive roller 16 and stops transporting the light-shielding paper 24 when the load jumps up. Thereafter, the control device starts rotating the spool 20 in the film take-up chamber to wind up the light-shielding paper. At the start of rotation of the spool 20, the hole 27 of the leader 24a moves toward the tip or peak of the claw 30 to be caught on the side projections 31. Thus, the leader 24a is secured to the spool 20. Further rotation of the spool 20 coils the leader 24 around the spool core 21 by a predetermined amount to position an initial unexposed frame in an exposure position.

When all available frames have been exposed by repeating shutter release and film wind-up operations, the trailer 24b of the light-shielding paper 24 is wound up onto the spool 20 of the film take-up chamber without stop. Since the trailer 24b has no hole like the hole 27 of the leader 24a, the trailer 24b will not be caught on the claw 30 of the spool 20 in the film supply chamber. Thereafter, the rear lid of the camera is opened to remove the exposed roll film from the film take-up chamber. The spool 20 left in the film supply chamber is replaced in the film take-up chamber for the next film loading.

It is possible to provide two holes 27a and 27b in the leader 24a on the same longitudinal line of the filmstrip, as is shown in FIG. 12. The hole 27 is not necessarily round but

oblong or any other shape that is large enough to fit on the claw **30** but provides secure engagement of the leader **24***a* with the claw **30** at the start of rotation of the spool **20**.

FIG. **13** shows a second embodiment of the invention, wherein a claw **30** is configured substantially the same way as in the first embodiment, but its guide surfaces **30***c* and **30***d* are inclined at a constant angle. Ribs **42** for pressing the leader **24***a* toward the claw **30** have a substantially triangular pyramid shape constituted of one perpendicular triangular side **42***a* and two oblique triangular sides **42***b* and **42***c* to a wall **23***c* of a slit **23**, and there are two guide surfaces **42***d* and **42***e* along the crest line between the side **42***a* and the sides **42***b* and **42***c*. These ribs **42** allows the leader **24***a* to enter the slit **23** from both entrances **23***a* and **23***d*. In addition, even if the center of the light-shielding paper **24** is deviated from the center of the slit **23** in the axial direction of a spool core **21**, because at least one of the edges of the light-shielding paper **24** is guided on the inclined crest line **42***f* between the oblique sides **42***b* and **42***c* of the rib **42**, as is shown in FIG. **14**A, the light-shielding paper **24** is centered again under the reactive force from the crest line **42***f*. In comparison, in a case where internal sides of ribs **45** are perpendicular to the wall **23***c* of the slit **23**, as shown in FIG. **14**B, the deviation of the leader **24***a* from the center of the slit **23** cannot be corrected any more if the deviation exceeds a certain degree.

In the embodiments shown in FIGS. **4** and **13**, the side projections **31** have an oblong cross section **31**A, as shown in FIG. **15**A. However, the side projections **31** may have other cross sectional contours **31**B, **31**C and **31**D, as shown in FIGS. **15**B, **15**C and **15**D, respectively. In either case, the edges of the side projection **31** that extend laterally to the film inserting directions (the directions shown by arrows in FIG. **15**A) are rounded, and the cross sectional contour of the side projections **31** is symmetrical.

FIG. **16** shows a spool **50** according to a third embodiment of the invention, wherein a plane center slit **52** having no claw and rib is formed through an axial center of a spool core **53**, and a pair of engaging slits **51** each having a claw **55** and a pair of ribs **56** for engagement with the light-shielding paper **24** are formed in parallel to the center slit **52** on opposite sides thereof. The center slit **52** is used in manufacturing the roll film, that is, in winding an unexposed film on the spool **50**. This embodiment allows holes for engagement with the claw **55** to be provided in both the leader and the trailer of the light-shielding paper.

As shown in FIGS. **17** and **18**, the claw **55** has side projections **55***a* and **55***b* protruding from lateral sides of the claw **55** with respect to the film inserting direction. In each engaging slit **51**, the claw **55** is disposed on a wall **51***a* of the slit **51**, that is closer to the periphery of the spool core **53**, whereas the ribs **56** are disposed on opposite lateral sides of the claw **55** on an opposite wall **51***b* to the wall **51***a*, that is, the wall **51***b* closer to the axial center of the spool core **53**. However, it is possible to dispose the claw **55** on the wall **51***b*, and the ribs **56** on the wall **51***a* in each slit **51**.

The ribs **56** and the claws **55** have symmetrical triangular crest lines **56***a* and **56***b*; **55***c* and **55***d*, respectively, which extend in radial directions of the spool core **53**, as shown in FIGS. **17** and **19**. In other words, the crest lines **55***c* and **55***d* of the claw **55** form an equal angle $\alpha1=\alpha2$ to each other with the wall **51***a*, and the crest lines **56***a* and **56***b* of the rib **56** form an equal angle $\beta1=\beta2$ to each other with the wall **51***b*. Therefore, the light-shielding paper **24** can smoothly be inserted into either of the slits **51** from either entrance.

Providing that the claw **55** has a height h4 from the wall **51***a*, that the ribs **56** have a height h5 from the wall **51***d*, that the side projections **55***a* and **55***b* have a thickness t2, and that the walls **51***a* and **51***b* have a distance H2 from each other, it is desirable to satisfy the following condition: $H2+t2<h4+h5<2\cdot H2$.

In particular, H2 is most preferably 1.8 mm to 2.8 mm, whereas h4+h5 is most preferably H2+t2+(0.1 mm to 0.3 mm). In other words, it is most preferable that the claw **55** and the ribs **56** overlap each other in the width direction of the slit **51** by an amount t2+(0.1 mm to 0.3 mm).

In alternative, an engaging slit **57** may have a pair of claws **58** on opposite lateral sides of a single rib **59** with respect to the film inserting direction into the slit **57**, as is shown in FIG. **20**. For use with this embodiment, a pair of holes **27***c* or two pairs of holes **27***c* and **27***d* are to be formed through the leader **24***a* of the light-shielding paper **24**, as shown in FIG. **21**, wherein the two holes **27***c* or **27***d* of each pair are disposed side by side in the lateral direction of the light-shielding paper **24**, that corresponds to the film inserting direction.

FIGS. **22** and **23** show another embodiment of the invention, wherein a spool **60** has a pair of claws **61** and a rib **62** in each of two engaging slits **63** which are disposed on opposite sides of a center plane slit **64**. Moreover, the claws **61** and the rib **62** have a single guide surface **61***a* or **62***a* each, to permit insertion of the leader **24***a* of the light-shielding paper **24** from an entrance **63***a* of the slit **63**, as is shown in FIG. **23**. The leader **24***a* is guided along the guide surfaces **61***a* and **62***a* till a pair of holes of the leader **24***a*, like **27***c* or **27***d* of FIG. **21** are caught on hook portions **61***b* of the claws **61**.

The present invention should not be limited to the embodiments as described so far. For example, the triangular pyramid like rib **42** may be replaced by a semi- or half-conical rib. The guide surfaces of the claw that face the entrances of the slit may have three or more different inclination surfaces, or may be a curved surface. In that case, the above inclination angle θ is assumed to be a tangential angle at the final contact point P2.

Meanwhile, it is well-known that ISO 135 film has film data such as film speed data recorded or printed on its cassette shell, so that a camera can read the film data to use for controlling exposure automatically. However, the conventional 120- and 220-size roll films have no such mechanically readable film data, so that the photographer must manually adjust the camera to the type of the 120- or 220-size roll film. It has been desired to provide the 120- and 220-size roll films with film data to permit automatic exposure control of the camera.

FIG. **24** shows a 120-size photographic film having film data recorded thereon, according to a preferred embodiment of the invention. As shown from a lateral side in FIG. **25**, a Brownie size filmstrip **72** is secured at its leading end to a light-shielding backing paper **73** with an adhesive tape **71**. And a bar code **74** is printed on the outer surface of the adhesive tape **1**. In a 220-size photographic film, it is preferable to provide a bar code on one of two adhesive tapes which secures a leading end of a filmstrip to a leader. The bar code **74** preferably includes film data such as film speed data, from ISO 25 to ISO 3200, film size data to discriminate between 120-size or 220-size, film type data to discriminate between a color photography film and a black-and-white photography film, and between a reversal film and a negative film, and so forth. Since the camera can read from the bar code **74** the film data indispensable for automatic exposure control of a camera, including the film speed, film size and film type data, the camera can automatically control exposure with respect to the 120-size or 220-size film, like 135-size photographic film.

Providing the bar code **74** on the adhesive tape **71** in a leading portion of the film is preferable because of the following reasons:

(1) The bar code **74** may be used for detecting the start of the camera in addition to film data detection;

(2) As the adhesive tape **71** of the leading portion of the film is opposed to an optical system of the camera when the rolled film is loaded in the camera, it is possible to provide a data reading device on one side of the optical system without the need for a large change in the camera construction;

(3) The adhesive tape **71** may have a bright color such as white that facilitates printing of the bar code **74**; and

(4) The bar code **74** can be printed on the adhesive tape **71** in the same manufacturing line as film winding.

It is possible to provide film data in form of a DX code or a CAS (Camera Auto Sensing) code which is constituted of a pattern of conductive segments and isolated segments, and is electrically readable. In either case, the code on the adhesive tape **71** may be used for the camera to detect the start of film preliminary winding, in addition to film data detection. And the DX code or the CAS code can be provided by pattern printing. However, pattern printing of conductive segments is expensive compared with bar code printing. Moreover, electric contacts of the camera for use in detecting the DX or CAS code can scratch the photosensitive emulsion surface of the filmstrip **2**, for example, if the contacts protrude toward the filmstrip **2**. It is to be noted that the conductive segments of the CAS code are arranged in checkers, while the conductive segments of the DX code are arranged in stripes.

FIG. **26** shows another embodiment of the invention wherein a bar code **74A** is provided on a reverse surface **75** of a light-shielding paper **73** in a leading portion thereof. Although this embodiment is illustrated as a 120-size film in FIG. **26**, this embodiment is applicable to a 220-size film.

It is preferable to provide a printing area on the reverse surface **75** to facilitate printing. Also in this embodiment, the bar code **74A** can be printed in the same manufacturing line as film winding. However, to use the bar code **74A** additionally for start detection, it is necessary to provide a specific data reading device, for example in a holder in Omega type cameras. In forward winding type cameras where the film is advanced one frame after each exposure from a film supply chamber to a film take-up chamber, the data reading device must be provided on inside of a rear lid or the film supply chamber or the take-up chamber, since the reverse surface **75** faces the rear side of the camera.

It is possible to provide an electrically readable code constituted of conductive segments and isolated segments by pattern printing, instead of the bar code **74A**. However, also in that case, to use the code additionally for start detection, it is necessary to provide a specific data reading device, for example in a holder in Omega type cameras, or on inside of a rear lid or a film supply chamber or a take-up chamber in the forward winding type cameras. Because the 120-size and the 220-size roll films have different roll diameters, it is difficult to use a common electric contact to read the code on both types. Besides being costly, it is necessary to provide an optical position detecting device if the electric data reading device is disposed on inside of the rear lid.

It is possible to provide a bar code **74B** on an obverse surface **73***a* of a light-shielding paper **73** on which a filmstrip **72** and an adhesive tape **71** are disposed. As implied by hatching, the obverse surface **73***a* has a dark color such as black for enforcing the light-shielding effect on the filmstrip **72**. It is desirable to dispose the bar code **74B** in a leading portion of the film, for the same reason as described above. As the obverse surface **73***a* is opposed to the optical system of the camera, it is possible to provide a bar code reading device on one side of the optical system without the need for a large change in the camera construction. However, indeed it is possible to print the bar code **74** on the obverse surface **73**, but it is necessary to print a bright background area behind the bar code **74B**, or to use matt ink for printing the bar code **74B**. This would rise the printing cost. To reduce the cost, it is possible to replace the bar code **74B** with a punched pattern which is optically readable through a transmission type photo sensor or the like. When punching the light-shielding paper, it is necessary to design the light-shielding paper and the punched pattern so as to keep a sufficient mechanical strength of the roll film.

It is possible to provide an electrically readable code constituted of conductive segments and isolated segments by pattern printing, instead of the bar code **74B**. However, pattern printing of conductive segments is costly compared with bar code printing. Moreover, electric contacts of the camera for use in detecting the electrically readable code can scratch the photosensitive emulsion surface of the filmstrip **2**.

FIG. **28** shows a further embodiment of the invention wherein film data **74C** is provided on an end face of a flange **76** of a spool. In this embodiment, a data reading device may be easily disposed in a film supply chamber of a conventional camera. As the film data **74C**, a bar code can be printed with each on the end face of the flange **76**. However, it is hard to use the film data **74C** on the flange **76** for start detection by the camera. Therefore, this embodiment is disadvantageous in view of cost.

It is also possible to provide the film data **74C** as an electrically readable code such as a DX code or a CAS code by pattern printing. In this case, an electric data reading device can easily be disposed in proximity to the key shaft of the film supply chamber. However, since it is hard to use the film data **74C** on the flange **76** for start detection by the camera, this embodiment is disadvantageous in view of cost.

Accordingly, it is most preferable to print a bar code on the adhesive tape **71**. In the bar code, data pieces may be arranged in an appropriate sequence in the bar code. For example, camera start data, film speed data, film size data, film type data, and end data are preferably arranged in this order from the leader of the film. It is also possible to provide clock data track in parallel with film data track in the bar code. The bar code may be those defined according to JIS B9550-1978. It is possible to provide the bar code by putting labels with bar codes to the light-shielding paper or the adhesive tape or the spool. But it is preferable to provide the bar code directly by off-set or gravure printing, ink jet printing or hot-stamping.

EXAMPLE

The followings are compositions of a preferred example of roll film according to the invention.

The light-shielding paper was composed as follows:

A base paper of 75 μm to 80 μm and 80 g/m^2 was made from a mixed pulse consisting of 30% conifer pulp and 70% latifoliate tree pulp, added with cation polyacryl amide as a paper pulp reinforcer, rosin derivative as a sizing agent, aluminum sulfate as a bonding agent, and polyvinyl-alcohol containing calcium carbonate and titanium oxide as a surface sizing agent, by means of a wire paper machine. A light-shielding film of 20 μm was made from LDPE containing 18 wt % acetylene black by an inflation method. The light-shielding film was cemented to the base paper with a

polyurethane dry laminating adhesive, and a gravure printing was made on the base paper surface with an ink consisting of polyamide/pyroxylin resin mixture and a pigment as a coloring agent. The printed surface was coated with 1 μm to 2 μm polymethyl-methacrylate as an overcoat or protection layer by gravure printing, thereby providing the light-shielding paper having a total thickness of 100 μm to 105 μm.

As the photographic filmstrip, a photographic film having a total thickness of 95 μm and a film speed of ISO 400 was used.

Adhesive tape was composed as follows:

A base layer was made from a mixed pulse consisting of 20% conifer pulps and 80% latifoliate tree pulps, added with cation-polyacrylamide as a paper pulp reinforcer, rosin derivative as a sizing agent, aluminum sulfate as a bonding agent, by means of a wire paper machine and, thereafter, the base layer was coated with a white layer of 12 μm consisting of kaoline, calcium carbonate and titanium oxide dispersed in polyvinyl-alcohol and acrylic emulsion, to provide a base paper having a total thickness of 100 μm. Then, a layer of 30 μm isoprene group adhesive is formed as a pressure-sensitive adhesive on the opposite surface of the base paper from the white layer. The bar code was printed on the white layer by hot-stamping for the adhesive tape to be used in the leading portion of the film.

To manufacture a 120-size photographic film, the photographic filmstrip was attached to a center area of the light-shielding paper and was secured at its leading and trailing ends with the adhesive tapes.

The base paper for the light-shielding paper of the roll film of the invention may be any of those which are made mainly from natural pulps, or from a mixture of natural pulps and synthetic fibers or pulps at an appropriate mixture ratio. It is also possible to make the base paper from pulps mixed with reprocessed pulps or to use multi-layered paper consisting of reprocessed pulp layers and natural pulp layers.

Preferable natural pulps are kraft pulps of conifer, latifoliate tree, or mixture thereof. As natural pulps for use with kraft pulps, sulfide pulps are preferable, but high-yield pulps such as SCP, CGP, TMP, RGP are applicable.

Various additive agents may be loaded in the base paper during adjustment of slurry of paper materials. It is particularly preferable to load some of the following agents:

Sizing agents: fatty acid metal salt and/or fatty acid, alkyl-ketene emulsion dimer or epoxy high-fatty acid amide that is disclosed in JPB62-7534, alkenyl- or alkyl-succinic acid anhydrous emulsion, and rosin derivative;

Dry paper reinforcer: anion-, cation- or ampholytic polyacryl amide, polyvinyl alcohol, cationic starch (e.g. JPA3-171042), and vegetable galacto mannan;

Wet paper reinforcer: polyamine-polyamide and epichlorohydrin resin;

Filler: clay, kaolin, calcium carbonate, titanium oxide etc.;

Bonding agents: water-soluble aluminum salt such as aluminum chloride and alumina sulfate;

pH adjuster: caustic soda, sodium carbonate, sulfuric acid etc.; and

Coloring pigment, coloring dye and/or fluorescent brightener such as disclosed in JPA63-204251 and JPA1-266537.

The base paper may further contain various additive agents such as water-soluble polymer, latex, emulsion and anti-static agents by coating, spraying, tab sizing, size press or other method.

As water-soluble polymer, there are starch polymer that is disclosed in JPA1-266537, polyvinyl alcohol polymer, gelatin polymer, polyacrylamide polymer, cellose polymer. As anti-static agents, there are conductive materials including non-ionic surface active agent such as polyoxyethylene glycol, cation surface active agent such as quaternary ammonium salt, ampholytic surface active agent, alkyl amine derivative, fatty acid derivative, several kinds of lubricant, carbon black, graphite, metallic surface coating pigment, metallic powder, metallic flake, carbon fiber, metallic fiber, whisker (potassium titanate, alumina nitride, and alumina). As concrete components, there are alkaline metal salt such as sodium chloride and potassium chloride, alkaline earth metal salt such as calcium chloride and barium chloride, colloid metallic acid such as colloid silica, and organic anti-static agent such as polystyrene sulphonate.

As latex or emulsion, there are petroleum resin emulsion, and latex such as styrene-acrylic acid-acrylic ester copolymer, styrene-acrylic acid-butadiene copolymer, ethylene-vinyl acetate copolymer, and styrene-maleic acid-acrylic ester copolymer. As pigment, there are clay, kaolin, talc, barium sulfate, titanium oxide. As pH adjuster, there are hydrochloric acid, phosphoric acid, citric acid and caustic soda.

The base paper may have a complete light-shielding property by itself, or a light-shielding layer may be additionally formed on the base paper. In either case, the base paper may be a black paper to supplement the light-shielding effect. The black paper preferably contains 1 wt % to 15 wt % furnace carbon black having an average particle diameter of 15 μm to 80 μm and 0.1 wt % to 10 wt % synthetic zeolite having an average particle diameter of 0.1 μm to 5 μm. The base paper may further contain 0.01 wt % to 5 wt % cationic water-soluble polymer and 0.1 wt % to 2 wt % cationic black or blue dye (dye whose coloring portion is loaded with positive electric charge, such as diallyl methane, triallyl methane, thiazole, methine, xanthene, oxazine, thiazine, azo, and anthraquinone).

The base paper is made from the paper material slurry loaded with the additive agents according to an appropriate paper making method such as disclosed in JPA58-37642, JPA61-260240 and JPA61-284762, by use of a conventional paper machine such as a wire paper machine or a cylinder paper machine, so as to obtain equal formation, and thereafter is subjected to calendaring by use of machine calender, super calender or thermal calender, to have a weight of 50 g/m^2 to 100 g/m^2, preferably 60 g/m^2 to 90 g/m^2, and a thickness of 45 μm to 120 μm, preferably 60 μm to 100 μm. Regarding physical properties, it is preferable that the base paper has a smoothness of 90 seconds or more, preferably 120 seconds or more in the Beck smoothness that is defined in JIS P-8119 so that the photographic film may not suffer scratches, pressure fogging or other damage from unevenness of the light-shielding paper surface, and that the gap between the photographic film and the light-shielding paper may be minimized to improve light-shielding properties and moisture barrier properties. The base paper preferably has an air permeability of 500 seconds or more when measured according to JIS P-8117, and a sizing degree of 10 seconds or more in Stöckigt sizing degree (JIS P-8122) in view of after-processing, or to give a sufficient water- and moisture-resistance to the light-shielding paper.

For the present invention, tensile strength at break of the hole of the light-shielding paper in relation to the claw of the spool is an impotent factor. Since it is desirable that the load applied during the film winding is about 200 g to 300 g to draw the film, and that engaging force is 500 g or more.

Therefore, the base paper preferably has a tensile strength of 4.5 Kgf/15 mm or more in the longitudinal direction (JIS P-8113) and a tearing strength of 35 gf or more (JIS P-8116).

As thermoplastic resins for forming the light-shielding layer on the rear surface of the base paper, those disclosed in U.S. Pat. Nos. 2,646,365, 2,646,366, 2,751,309, and 2,959,492, FR-1449852, JPA51-49205, JPA48-22020, JPA50-67644, JPA55-140835, JPA58-17434, JPA58-186744, JPA59-68238, JPA60-35728, JPA6-51450 etc. are applicable. That is, one of polyolefin group resin such as several kinds of low-, middle- and high-density polyethylene, and linear low density polyethylene and polypropylene; polyvinyl group resin such as ethylene vinyl acetate; acrylic resin such as ethylene ethyl acrylate and ethylene methyl acrylate; rubber resin such as styrene butadiene; monomer such as ionomer; graft copolymer polyamide group resin; and polyester resin such as polyethylene terephthalate; or a blend or copolymer of two or more of these resins. It is also possible to form more than one resin layer overlaid on the rear surface of the base paper.

As the light-shielding material added to the resin, carbon black, titanium nitride and graphite are preferable as light-absorbing light screen materials having superior light-shielding properties. Among these, carbon black is preferable in view of light-shielding properties, cost and physical properties, of which furnace carbon black is popular and preferable, but channel carbon black or thermal carbon black is also applicable. Acetylene carbon black and Ketchen carbon black being a denatured by-product, are preferable because of their light-shielding properties as well as anti-static properties.

Considering the use in the light-shielding paper for photographic film, carbon blacks are required to have smaller unfavorable effect on the photographic film, such as fogging and disordering of film sensitivities, but provide sufficient light-shielding effect. In this point of view, preferred are those furnace carbon blacks of pH 6.0 to 9.0, having an average particle diameter from 10 μm to 120 μm, more preferably from 15 μm to 100 μm, and most preferably from 20 μm to 80 μm, a volatile content of 2.0% or less, more preferably 1.0% or less, and most preferably 0.5% or less, and an oil-absorption factor of 50 ml/100 g or more, more preferably 70 ml/100 g or more, and most preferably 100 ml/100 g or more, because they are not apt to provide pin holes, hard spots or fish-eyes in resin film or coat, and improve light-shielding properties and dispersing properties, as well as less adversely affect photographic properties and physical properties.

Representative examples of preferred carbon blacks on the market include Carbon Black #20(B), #30(B), #33(B), #40(B), #41(B), #44(B), #45(B), #50(B), #55(B), #100(B), #600(B), #2200(B), #2400(B), MA8, MA11 and MA100, all produced by Mitsubishi Kasei Corporation; Black Pearls 2, 46, 70, 71, 74, 80, 81 and 607, Regal 300, 330, 400, 660, 991 and SRF-S, Vulcan 3 and 6, Sterling 10, S0, V, S, FT-FF and MT-FF, all produced by Cabot Co., Ltd.; and UNITED R, BB, 15, 102, 3001, 3004, 3006, 3007, 3008, 3009, 3011, 3012, XC-3016, XC-3017 and 3020, all produced by Ashland Chemical Co. However, the carbon black is by no means limited to these examples.

There are mainly three methods of forming on the base paper a resin layer containing 4 wt % to 30 wt % light-shielding material as above.

One is coating and drying a liquid of the resin dispersed or solved in an organic solvent or water. The liquid may be coated by reverse roll coating, blade coating, air knife coating, rod coating, flood coating, extrusion coating, gravure coating, or any other appropriate coating method. According to this method, the thickness of the consequent dried resin coat is appropriately 1 μm to 25 μm.

Another is hot-melt coating of the resin, wherein extrusion coating is usual, but any other method is applicable. According to this method, the thickness of the consequent dried resin coat is appropriately 5 μm to 60 μm.

The third method is forming a uniform resin film of 20 μm to 40 μm by inflation, T-die, casting, or rolling, and then cementing the resin film to the base paper by dry lamination with a polyurethane group or a polyether group adhesive at a thickness of 1 g/m^2 to 3 g/m^2. Any of the above methods is applicable to the light-shielding paper of the present invention.

The ink for use in printing information such as the bar code and decorative patterns on the light-shielding paper may be selected among from widely used inks for off-set printing or gravure printing and UV inks, but those having no harmful influence on photographic materials.

Representative examples of appropriate synthetic resin for ink are vinyl chloride/vinyl acetate resin copolymer; nitrate pyroxylin, polyester; polyamide urethane; polyacryl; rosin denatured maleic acid; ethylene-vinyl acetate; vinyl ether; urethane-vinyl acetate; vinyl acetate-urethane resin; modified alkyd resin, modified phenol resin; alkaline soluble resin including rosin modified maleic acid resin, styrene maleic acid resin, styrene acrylic resin, acrylic ester acrylic resin, and methacrylic ester acrylic resin; hydrosol-type resin including styrene maleic acid resin, styrene acrylic resin, α-methyl styrene acrylic resin, acrylic ester acrylic resin, and methacrylic ester acrylic resin; emulsion-type resin including styrene resin, styrene acrylic ester resin, acrylic ester copolymer resin and methacrylic ester copolymer resin. As resins for ultraviolet ink, polymers with acrylic unsaturated group are usual. Representative examples are polyester/acrylic ester, polyester/urethane resin/acrylic ester, epoxy resin/acrylic ester, pentaerythritol triacrylate, trimethylol propane triacrylate, hexane diol diacrylate, triethylene glycol diacrylate, triethylene glycol diacrylate, and hydroxy ethyl methacrylate.

These inks are used with well-known colorant. Examples of these colorants are several kinds of pigments disclosed in JPA63-44653 and so forth:

Azo-pigments: azo lake such as carmine 2B, red 2B; insoluble azo such as monoazo yellow (PY-1, -3), disazo yellow (PY-12, -13, -14, -17, -83), pyrazolone orange (PO-B-34), Balkan orange (PO-16); overall azo group such as chromophthal yellow (PY-93, -95), chromophthal red (PR-144, -166);

Polycyclic pigments: phthalocyanine group such as copper phthalocyanine blue (PB-15, -15-1, -15-3), copper phthalocyanine green (PG-7); dioxazine group such as dioxazine violet (PV-23); isoindolinone group such as isoindolinone yellow (PY-109, -110); durene group such as pellilene, perinone, flavanthrone, thioindigo; lake pigments such as malachite green, rhodamine B, rhodamine G, Victoria blue B;

Inorganic pigments: oxide such as titanium dioxide, blood red; sulfate such as sedimentary barium sulfate; carbonate such as sedimentary calcium carbonate; silicate such as hydrous silicate, anhydrous silicate; metal powder such as aluminum powder, bronze powder, zinc powder, carbon black, chrome yellow, iron blue etc. These pigments are applicable as light-shielding materials for the above-described resin or the paper layer. In addition, oil-soluble

dye and dispersing dye are applicable. The ink may further contain several kinds of solvents, dispersing agents, wetting agents, anti-foaming agents, leveling agents, tackifier, stabilizer, cross-linking agents, wax, drier.

It is possible to use an ink jet printing method for bar code printing. For ink jet printing, there are generally aqueous ink and solvent type (oil-soluble) ink. The aqueous ink may contain water-soluble dye as colorant, water as solvent, monohydric- and dihydric alcohol as water-soluble solvent, polyhydroxy alcohol, water-soluble nitride composition or moisture-absorbing organic composition as a wetting agent. As the oil-soluble ink, those are applicable which contain an oil-soluble dye as colorant, and low water-soluble solvent such as glycol ether and ester, or water-insoluble solvent such as isoparaffin as solvent, and whose viscosity is controlled in a range from 2 to 10 centipoise.

It is also possible to provide the bar code by hot-stamping. In that case, the bar code is formed on a heat-transfer film, and is transferred to the designated position on the roll film.

Good examples of ink for hot-stamping are those which use heat-resistant pigments such as carbon black, iron blue, phthalocyanine blue, lake red G, calcium carbonate, alumina white, clay, titanium dioxide, and are also loaded with extender pigments such as silica and barium sulfate for improving cutting properties, and pigments with smaller oil-absorbing factor. As the resin for the hot-stamping ink are applicable the followings: hard resins such as rosin ester, terpene phenol, petroleum resin; acrylic copolymer, ethylene-vinyl acetate copolymer, cyclic rubber, vinyl chloride-vinyl acetate copolymer, wax monomer or wax mixture such as natural carnauba wax, montan wax, synthetic wax, low-molecular polyethylene etc.

Where the bar code is to be printed either on the black obverse surface of the light-shielding paper or on the spool, it is necessary to print a background area in white, yellow or silver. Thereafter, the bar code is printed in black or a dark color, or as blank segments.

In this embodiment, those inks are preferable which use inorganic pigments such as titanium oxide, clay, mica, alumina, calcium silicate, aluminum hydroxide, calcium carbonate, barium sulfate; or metallic powder pigments such as aluminum powder, bronze power.

It is possible to coat the light-shielding paper with a protection layer called lacquer coat or varnish for surface glossing as well as for protection of the printed area. As the protection layer, an appropriate one or more of various resins are applicable, including acrylic resin, cellulose resin such as acetate fibrous material, urethane resin, epoxy resin, polyester resin, ionomer resin, EEA resin, various polyethylene resin including low density-, high density- and linear low density polyethylene, polypropylene resin etc. Wax is also applicable.

Stiffness is another important properties of the light-shielding paper. A certain stiffness is necessary to permit and facilitate insertion of the light-shielding paper into the slit of the spool, while the light-shielding paper must be soft and flexible to permit tight winding and prevent unwinding. Accordingly, the stiffness of the light-shielding paper is preferably 100 mgf to 200 mgf, and more preferably 120 mgf to 160 mgf in Gurley stiffness.

The light-shielding paper for use in the invention may be light-tight black paper or those consisting of base paper and a carbon black dispersed resin layer coated or laminated on the base paper. The light-shielding paper should be capable of bearing bar codes, electrically readable codes or the like thereon by printing or sticking.

Particular examples of the light-shielding paper are as follows:

A light-shielding paper provided with at least an aluminum layer on base paper, which prevents sticking of the light-shielding paper with the photographic film in hot and humid conditions, gas fogging of the photographic film, clockspringing or unwinding of the roll that could be caused by a high stiffness in flexure, and dimensional instability that could be caused by moisture absorption, as disclosed in JPA55-140835 and JPB61-36216;

A light-shielding paper provided with a layer consisting of high density polyethylene and low density polyethylene so as to improve antistatic properties and cutting properties on punching, as disclosed in JPA60-35728;

A light-shielding paper provided with a lamination film consisting of ethylene polymer, acrylic ester, methacrylic ester, and vinyl acetate/ethylene copolymer, so as to improve low temperature heat sealing capacity, mixed material sealing capacity and cutting properties, as disclosed in JPA59-68238;

A light-shielding paper which prevents neck-in on melt extrusion of middle and surface layers on the base material, as disclosed in JPA58-186744;

A light-shielding paper which has a polyolefin or polyolefin mixture layer on one or each side, as disclosed in JPA58-17434;

A light-shielding paper provided with a paint having an absorption band in a wavelength range of not less than 550 mμ to improve light-shielding capacity, as disclosed in JPA52-150016;

A light-shielding paper coated with copolymer of methyl methacrylate, methacrylic acid, ethyl acrylate and so forth, as disclosed in JPA50-67644;

A light-shielding paper coated with copolymer of ethylene and at least one of acrylic ester and methacrylic ester, as disclosed in JPA48-22020 and JPB51-49205;

A light-shielding paper provided with a plurality of carbon black layer on the base paper, as disclosed in U.S.P.T. No. 871004;

A light-shielding paper provided with printing on one surface, and a carbon black containing polyethylene layer on the opposite surface by extrusion laminating, as disclosed in U.K.P. No. 1156302;

A light-shielding paper provided with a protection layer on the printed surface, and a carbon black containing vinylidene chloride or styrene/butadiene copolymer layer on the opposite surface, as disclosed in U.S. Pat. Nos. 2,646,365, 2,646,366, 2,751,309, 2,959,492 and 3,053,779;

A light-shielding paper provided with carbon black containing polyethylene on its surfaces by extrusion, as disclosed in French Patent No. 1449852 and U.K.P. No. 1071032; and

A light-shielding paper coated with a mixture of ethylene-vinyl acetate copolymer and carbon black, as disclosed in German Patent No. 1903378.

As the adhesive tapes, those are applicable which permit printing or stamping bar codes or conductive segments and isolated segments on one side of a base material such as paper and plastic film, and which are provided with a pressure-sensitive adhesive on the opposite side of the base material. Good examples of the pressure-sensitive adhesive are rubber-based adhesives composed of rubber, such as styrene-isoprene-styrene block copolymer, styrene-butadiene rubber, polybutene rubber, polyisoprene rubber, butyl rubber, natural rubber and synthetic isoprene, loaded

with tackifying resin to control glass transition temperature, such as rosin, dammar, copal, hydrogenated rosin, rosin ester, indene-coumarone, picopal, polyterpene, nitrocelullose, alkyd resin, buton and xylene resin, softening plasticizer such as DOP, TCP, DBP and BBP, paraffin chloride, animal and vegetable fats and oils, and mineral oils; acrylic pressure-sensitive adhesive composed of homopolymer or copolymer solved in an appropriate solvent, the homopolymer or copolymer being those of acrylic ester such as methyl acrylate, ethyl acrylate, butyl acrylate, hexyl acrylate, 2-ethyl-hexyl acrylate, isooctyl acrylate, octyl acrylate, decyl acrylate, or those of methacrylic ester such as methyl methacrylate, ethyl methacrylate, butyl methacrylate, hexyl methacrylate, 2-ethyl-hexyl methacrylate, isooctyl methacrylate, octyl methacrylate, decyl methacrylate; or copolymer of these ester compounds and vinyl compounds having functional group, such as acrylic acid, methacrylic acid, itaconic acid, crotonic acid and maleic acid. When copolymer with functional group is used, a small amount of isocyanate group organic cross-linking agent which acts on the functional group is loaded to increase heat-resiliency and cohesive effect.

In alternative, the adhesive tapes may be provided with heat-sensitive adhesives: those of polyolefin such as polyethylene; those of vinyl acetate copolymer such as ethylene-vinyl acetate copolymer; those of acrylic ester copolymer such as ethylene-ethylene acrylate and ethylene-isobutyl acrylate; those of polyamide such as nylon 6, nylon 6.6, nylon 10, nylon 12 and N-methoxymethyl-nylon; terephthalate adhesives; polyester adhesives; polyvinyl butyral adhesives; polyvinyl acetate adhesive; those of cellulose derivatives such as acetate, methyl cellulose, acetate-butyrate; those of polymethacrylic acid ester such as polymethyl methacrylate; those of polyvinyl ether such as polyvinylmethyl ether; polyurethane adhesive; polycarbonate adhesive; those of styrene block copolymer such as styrene-butadiene-styrene; those of synthetic rubber such as styrene-butadiene, isoprene and butyl rubber; those of special rubber other than the above; and a mixture of one or more of those acrylic copolymers other than the above.

For the spool of the roll film according to the invention, polystyrene resin is generally used because of its strength, heat-resistant properties, dimensional stability and appearance. Also a blend of general polystyrene resin (GPPS) and high impact or middle impact polystyrene resin (HIPS or MIPS) which is made by polymerizing styrene monomer with a synthetic rubber such as butadiene rubber, HIPS or MIPS alone, and a blend of GPPS with a rubber are applicable, of which the blend of HIPS and GPPS, or MIPS alone is preferable in view of impact strength and wearing resistance.

A preferable loading of the rubber is 0.5 wt % to 6.0 wt % considering the price, physical strength, injection molding facility, surface strength (resistance against scratch and wearing) and appearance. If the rubber loading is below 0.5 wt %, sufficient physical and surface strengths cannot be obtained. But above 6.0 wt %, injection molding facility, stiffness, appearance and price are too bad to use in practice.

For polymerization, any of three methods popular today is applicable: bulk polymerization wherein the monomer is polymerized without any solvent and dispersing agents, as is disclosed in JPA64-91136; random bulk polymerization as being generally industrialized wherein the monomer, catalyst and a small amount of solvent are used; and suspension polymerization wherein the monomer is dispersed in a medium in which the monomer is not or hardly soluble, and a polymerization initiator is used that is hardly soluble in the medium but easily soluble in the monomer.

Because the spool for the Brownie film should shield the photographic film from extraneous light in cooperation with the light-shielding paper, the spool must have light-shielding properties. Representative examples of light-shielding agents added to the resin for forming the spool are inorganic compounds as referred to below:

1) Oxide, such as: silica, diatomaceous earth, alumina, titanium oxide, iron oxide, zinc oxide, magnesium oxide, antimony oxide, barium ferrite, strontium ferrite, beryllium oxide, pumice stone, pumice stone balloon, and alumina fiber.
2) Hydroxide, such as: aluminum hydroxide, magnesium hydroxide, and basic magnesium carbonate.
3) Carbonate, such as: calcium carbonate, magnesium carbonate, dolomite, and danalite.
4) Sulfate and sulfite, such as: calcium sulfate, barium sulfate, ammonium sulfate, and calcium sulfite.
5) Silicate, such as: talc, clay, mica, asbestos, glass fiber, glass balloon, glass bead, calcium silicate, montmorillonite, and bentonite.
6) Carbon, such as: carbon black, graphite, carbon fiber, and carbon hollow sphere.
7) Other compounds, such as: iron powder, copper powder, lead powder, tin powder, stainless steel powder, pearlescent pigment, aluminum powder, molybdenum sulfide, boron fiber, zeolite, boron fiber, silicon carbide fiber, brass fiber, potassium titanate, lead titanate zirconate, zinc borate, barium methaborate, barium methaborate, calcium borate, sodium borate, and aluminum paste.

Among the above, carbon black is preferable, because it fogs less the photographic film, has little influence on photosensitivity and a great capacity for shielding light, and less produces spitting or hard spot in polystyrene resin.

Carbon black is classified according to raw materials as gas black, furnace black, channel black, anthracene black, acetylene black, Ketchen carbon black, thermal carbon black, lamp black, oil smoke, pine smoke, animal black, vegetable black, and so forth. Among of these, furnace black is preferable considering its light-shielding capacity and cost, as well as because it improves physical properties, and has less influence on photographic properties. Acetylene carbon black and Ketchen carbon black, a denatured by-product, are also preferable as having antistatic properties as well as light-shielding capacity, through they are expensive.

Among of the carbon blacks, those are preferable which is pH 6.0 to 9.0, and more preferably 6.5 to 8.5 (JIS K-6221), and having an average particle diameter of 10 μm to 120 μm, and more preferably 12 μm to 70 μm. Among of these, more preferred is furnace carbon black whose volatile component is not more than 3.5%, and most preferably 1.5% (JIS K-6221), and whose DBP oil absorption is not less than 50 ml/100 g, and most preferably not less than 70 ml/100 g (Method A of oil absorption measurement according to JIS K-6221). Channel carbon black is not preferable because it is expensive, and mostly contain more than 5.0% volatile component so that it can fog the photographic film. Most lamp black is pH 5.0 or less, so it has bad influence on the photographic properties. Therefore, if lamp black should have to be used, its influence on the photographic properties must be studied in advance. To evade adverse influence on the photographic properties, sulfur component of the carbon black should be 0.9% or less, and preferably 0.7% or less

when measured according to ASTM D 1619-60. Especially, free sulfur component should preferably be 0.1% or less, and most preferably 0.05% or less.

Preferred examples of commercially available carbon black for the spool are the same as set forth above for the light-shielding paper.

A preferable loading of the furnace carbon black is 0.05 wt % to 3.00 wt %, in view of the price, physical strength of the spool, light-shielding capacity, influence on photographic properties of the film, injection molding facility, and appearance. Loading of less than 0.05 wt % furnace carbon black results in insufficient light-shielding capacity, so the photographic film is fogged, unless the spool is thick enough. Making the spool thick enough for obtaining sufficient light-shielding capacity with 0.05 wt % furnace carbon black elongates molding cycle so much that molding failure such as sink marks can be provided, in addition that it increases the necessary amount of resin and thus raises the material cost. Loading of more than 3.00 wt % results in raising the cost and lowering physical strength of the spool, and weld marks are liable to occur. Moreover, the spool tends to absorb moisture, which can adversely affect the photographic film, and deteriorate the appearance of the spool (silver streaking, uneven or lowered glossiness), and weaken the surface of the spool, i.e. the spool can easily get scratched or worn.

As the dispersing agent for the light-shielding agent, one or more of low molecular weight styrene polymer, polyethylene wax, polypropylene wax, derivatives of these compounds, ethylene-bis-amide group and metallic soaps is applicable. A preferable example is zinc stearate or magnesium stearate. Carbon black containing master-batch pellet can contain the dispersing agent to an extent that has no harm on the product. As for zinc stearate, however, a preferable range is 0.01 wt % to 0.3 wt % in the final molding product. If the loading of zinc stearate is more than 0.3 wt % of the final product, glossiness of the product and sweating on the metal molds are increased so much that obstacles may stick to the final molding product. However, loading of less than 0.01 wt % zinc stearate would have little dispersing effect.

The spool of the invention may contain lubricant, in order that the edges of the light-shielding paper may smoothly slide on the spool, and thus the tightness of the film roll on the spool may further be improved. Examples of lubricants applicable for this purpose are referred to below, as well as manufacturers thereof:

(1) Fatty acid amide lubricants:

Saturated fatty acid amide lubricants:

Behenic acid amide lubricants, such as DIAMIDE-KN (trade name; manufactured by Nippon Kasei Chemical Co., Ltd.); and

Stearic acid amide lubricants, such as ARMIDE-HT (trade name; manufactured by Lion Oil and Fats Co., Ltd.), ALFLOW-S-10 (trade name; manufactured by Nippon Oil and Fats Co., Ltd.), fatty acid AMAMID-AP1 (trade name; manufactured by Nippon Chemical Co., Ltd.), AMIDE-S AMIDE-T (trade name; manufactured by Nitto Chemical Industry Co., Ltd.), NEWTRON-2 (trade name; manufactured by Nippon Fine Chemical Co., Ltd.);

Hydroxy stearic acid amide lubricants:

Palmitic acid lubricants, such as NEWTRON-S-18 (trade name; manufactured by Nippon Fine Chemical Co., Ltd.), AMIDE-P (trade name; manufactured by Nitto Chemical Industry Co., Ltd.); and

Lauric acid amide lubricants, such as ARMIDE-C (trade name; manufactured by Loan Akzo Co., Ltd.), DIAMID (trade name; manufactured by Nitto Chemical Co., Ltd.);

Unsaturated fatty acid amide lubricants:

Erucic acid amide lubricants, such as ALFLOW-P-10 (trade name; manufactured by Nippon Oil and Fats Co., Ltd.), NEWTRON-S (trade name; manufactured by Nippon Fine Chemical Co., Ltd.), LUBROL (trade name; manufactured by I.C.I), and DIAMID-L-200 (trade name; manufactured by Nippon Chemical Co., Ltd.); and

Oleic acid amide lubricants, such as ARMO SLIP-CP (trade name; manufactured by Lion Akzo Co., Ltd.), NEWTRON and NEWTRON-E-18 (trade names; manufactured by Nippon Fine Chemical Co., Ltd.), AMIDE-O (trade name; manufactured by Nitto Chemical Industry Co., Ltd.), DIAMID-O-200 and DIAMID-G-200 (trade names; manufactured by Nippon Chemical Co., Ltd.), ALFLOW-E-10 (trade name; manufactured by Nippon Oil and Fats Co., Ltd.), and fatty acid AMIDE-O (trade name; manufactured by Kao Corporation);

Bis fatty acid amide lubricants:

Methylene bis behenic acid amide lubricants, such as DIAMID-NK-BIS (trade name; manufactured by Nippon Chemical Co., Ltd.);

Methylene bis stearic acid amide lubricants, such as DIAMID-200-BIS (trade name; manufactured by Nippon Chemical Co., Ltd.), ARMO WAX (trade name; manufactured by Lion Akzo Co., Ltd.), and BISAMIDE (trade name; manufactured by Nitto Chemical Industry Co., Ltd.);

Methylene bis oleic acid amide lubricants, such as LUBRON-O (trade name; manufactured by Nippon Chemical Co., Ltd.);

Ethylene bis stearic acid amide lubricants, such as ARMO SLIP EBS (trade name; manufactured by Lion Akzo Co., Ltd.); and

Hexamethylene bis stearic acid amide lubricants, such as AMIDE-65 (trade name; manufactured by Kawaken Fine Chemical Co., Ltd.); Hexamethylene bis oleic acid amide lubricants, such as AMIDE-60 (trade name; manufactured by Kawaken Fine Chemical Co., Ltd.), etc.

(2) Non-ionic surface active agent lubricants:

ELECTRO STRIPPER TS-2 and ELECTRO STRIPPER TS-3 (trade name; manufactured by Kao Corporation), etc.

(3) Hydroxy carbonate lubricants:

Liquid paraffin, natural paraffin, micro wax, synthetic paraffin, polyethylene wax (preferably 6000 or less in molecular weight), polypropylene wax (preferably 6000 or less in molecular weight), chlorinated hydrocarbon, fluorocarbon, etc.

(4) Fatty acid lubricants:

Higher fatty acid (those preferable number of carbon atoms is C_{12} or more, such as caproic acid, stearic acid, oleic acid, erucic acid, palmitic acid), oxy fatty acid, etc.

(5) Ester lubricants:

Fatty acid lower alcohol ester, fatty acid polyvalent alcohol ester, fatty acid polyglycol ester, fatty acid fatty alcohol ester, etc.

(6) Alcohol lubricants:

Polyvalent alcohol, polyglycol, polyglycerol, etc.

(7) Metallic soaps:

Compounds of higher fatty acids such as lauric acid, stearic acid, succinic acid, stearyl lactate, benzoic acid, hydroxy stearic acid, lactic acid, phthalic acid, ricinoleic acid, naphthenic acid, oleic acid, palmitic acid and erucic acid, and metals such as Li, K, Na, Mg, Ca, Sr, Ba, Zn, Cd, Al, Sn, Pb and Cd. Among of these, magnesium stearate, calcium stearate, zinc stearate and magnesium oleate are preferable.

(8) Montanic acid ester partial saponifier.

(9) Silicone lubricants:

Dimethyl polysiloxane of various grades and denaturation thereof (manufactured by Sinetsu Chemical Co., Ltd., and Toray Silicone Co., Ltd.

It is the most preferable to load 0.05 wt % to 2.20 wt % dimethyl polysiloxane lubricant of organo-polysiloxane group having a viscosity of 1,000 CS to 60,000 CS.

Examples of other additive agents which may be added as required to the resin for forming the spool are antioxidant, photo-stabilizer, ultraviolet absorber, nucleator and antistatic agent. Also filler such as alumina, kaoline, clay, calcium carbonate, mica, talc, titanium oxide and silica, or reinforcer such as glass roving, metallic fiber, glass fiber, glass milled fiber, carbon fiber may be added to reduce the shrinkage of the spool.

What is claimed is:

1. A photographic roll film having a photographic filmstrip, a light-shielding paper secured to said photographic filmstrip at least at a leading end thereof, and a spool having said photographic filmstrip with said light-shielding paper wound in a roll thereon, said photographic roll film comprising:

- at least a hole formed through a leader of said light-shielding paper;
- a slit formed through a spool core of said spool along an axial direction of said spool core;
- at least a claw formed on a first wall of said slit, said claw being engaged with said hole when said leader is inserted in said slit, wherein said claw has side projections in proximity to the peak, said projections extending in said axial direction of said spool core; and
- at least a rib formed on a second wall of said slit which is opposite and parallel to said first wall, said rib pressing said leader of said light-shielding paper toward said first wall.

2. A photographic roll film according to claim 1, wherein said rib has a height from said second wall, which is larger than a thickness of said light-shielding paper plus a distance from a peak of said claw to said second wall.

3. A photographic roll film according to claim 1, wherein said claw and rib are individually symmetrical about a plane extending through an axial center of said spool core and perpendicularly to said walls of said slit, and guide surfaces of said claw and rib which face open sides of said slit are inclined relative to said walls to taper off to respective peaks, and wherein said guide surfaces of said claw have an inclination angle θ at least in portions proximate said side projections, said inclination angle θ being defined as follows:

$$\tan\theta \geqq t1/(De-Df)$$

wherein

t1 is a thickness of said side projection;

De is a distance between forward edges of said side projections and an initial contact point of a rim of said hole with a forward one of said guide surfaces of said claw with respect to an inserting direction of said light-shielding paper into said slit; and

Df is a distance between said initial contact point and a final contact point of said rim with said forward guide surface of said claw, where said hole is engaged with said side projections.

4. A photographic roll film according to claim 3, wherein said side projections are disposed inward of said guide surfaces of said claw.

5. A photographic roll film according to claim 4, wherein said forward edges as well as rearward edges of said side projections with respect to said inserting direction are rounded.

6. A photographic roll film according to claim 5, wherein said hole is approximately round.

7. A photographic roll film according to claim 1, wherein said light-shielding paper has a width approximately equal to an axial length of said spool core, but said leader has a narrower tip portion whose width is less than an axial length of said slit that is shorter than said spool core, such that said hole is centered with a center portion of said claw when side edges of said leader come into contact with side margins of said slit.

8. A photographic roll film according to claim 7, wherein said claw is disposed in a center position of said first wall in the axial direction of said spool core, whereas there are a pair of said ribs disposed symmetrically about said claw, and wherein said leader of said light-shielding paper has a trapezoidal portion having side edges tapered toward said narrower tip portion, said narrower tip portion having a width slightly less than a spacing between said pair of ribs, and a length longer than a half width of said second wall of said slit.

9. A photographic roll film according to claim 8, wherein inside surfaces of said ribs that are opposed to said claw are convex or protruding toward said claw and are tapered off to respective peaks.

10. A photographic roll film according to claim 1, further comprising:

- flanges on opposite ends of said spool core; and
- annular recesses formed in an center area of inside surfaces of said flanges coaxially with said spool core.

11. A photographic roll film according to claim 1, wherein said photographic filmstrip is secured to said light-shielding paper with at least an adhesive tape, and data of said photographic roll film is provided on at least one of said light-shielding paper, said adhesive tape and said spool.

12. A photographic roll film according to claim 1, wherein said claw and rib are individually symmetrical about a plane extending through an axial center of said spool core and perpendicularly to said walls of said slit.

13. A photographic roll film having a photographic filmstrip, a light-shielding paper secured to said photographic film strip at least at a leading end thereof, and a spool having said photographic filmstrip with said light-shielding paper wound in a roll thereon, said photographic roll film comprising:

- at least one hole formed through a leader of said light-shielding paper;
- a first slit formed through an axial center of said spool core of said spool along an axial direction of said spool core, said first slit having no member to engage with said leader;
- a pair of second slits formed in parallel to said first slit on opposite sides thereof;

at least one claw formed on a first wall of each of said second slits, said at least one claw being engaged with said at least one hole when said leader is inserted in one of said second slits, wherein said at least one claw has side projections in proximity to the peak, said projections extending in said axial direction of said spool core; and

at least one rib formed in each of said second slits on a second wall which is opposite and parallel to said first wall, said at least one rib pressing said leader of said light-shielding paper toward said first wall.

14. A spool, for a photographic roll film, comprising:

a spool core having a slit formed therethrough along an axial direction of said spool core;

at least one claw formed on a first wall of said slit; and

at least one rib formed on a second wall which is opposite and parallel to said first wall of said slit, wherein said at least one claw and said at least one rib are individually symmetrical about a plane extending through an axial center of said spool core and perpendicularly to said walls of said slit.

15. A spool, for a photographic roll film, according to claim 14, further comprising:

flanges on opposite ends of said spool core; and

annular recesses formed in a center area of inside surfaces of said flanges and coaxially with said spool core.

16. A spool, for a photographic roll film according to claim 14, further comprising guide surfaces on said at least one claw and said at least one rib which face open sides of said slit and are inclined relative to said walls to taper off to respective peaks, and wherein:

said at least one claw includes side projections in proximity to its peak; and

said guide surfaces of said claw have an inclination angle θ at least in portions proximate said side projections, said inclination angle θ being defined as follows:

$$\tan\theta \geqq t1/(De-Df)$$

wherein

t1 is a thickness of said side projection;

De is a distance between forward edges of said side projections and an initial contact point of a rim of said hole with a forward one of said guide surfaces of said claw with respect to an inserting direction of a light-shielding paper into said slit; and

Df is a distance between said initial contact point and a final contact point of said rim with said forward guide surface of said claw, where a hole of the light-shielding paper is engaged with said side projections.

17. A photographic roll film according to claim 16, wherein said side projections are disposed inward of said guide surfaces of said claw.

18. A photographic roll film according to claim 14, wherein:

said at least one claw is disposed in a center position of said first wall in the axial direction of said spool core, whereas there are a pair of said ribs disposed symmetrically about said claw; and

inside surfaces of said ribs that are opposed to said at least one claw are convex or protruding toward said claw and are tapered off to respective peaks.

* * * * *

US005995201A

United States Patent [19]

Sakaguchi

[11] Patent Number: 5,995,201

[45] Date of Patent: Nov. 30, 1999

[54] DIGITAL PRINT METHOD

[75] Inventor: Yasunobu Sakaguchi, Kanagawa, Japan

[73] Assignee: Fuji Photo Film Co., Ltd., Kanagawa, Japan

[21] Appl. No.: 09/006,399

[22] Filed: Jan. 13, 1998

[30] Foreign Application Priority Data

Jan. 13, 1997 [JP] Japan 9-003843

[51] Int. Cl.[6] G03B 27/52; G03B 27/34; G03B 15/00

[52] U.S. Cl. 355/55; 355/40; 355/56; 399/45

[58] Field of Search 355/55, 30, 35, 355/38, 41, 56, 27, 40; 250/578.1; 358/296, 302, 293; 399/45, 48; 382/319

[56] References Cited

FOREIGN PATENT DOCUMENTS

6-217091 8/1994 Japan .
6-233052 8/1994 Japan .
6-245062 9/1994 Japan .

Primary Examiner—Safet Metjahic
Assistant Examiner—Peter B. Kim

[57] ABSTRACT

When no trimming is executed, the optical magnification is fixed and the electronic magnification is changed each time a print size changes in a film original having the same film size, even if recorded images have a different size. Further, the fixed optical magnification is the standard or set optical magnification, which permits the image of the film original to be projected to the effective image region of the image sensor in the state that it inscribes or nearly inscribes the effective pixel region to the greatest possible degree. As a result, a high quality print can be obtained without the deterioration of image quality in high productivity, and without the need of effecting the troublesome optical magnification by operating the zoom lens. Further, when trimming is executed, since preference is given to the optical magnification over the electronic magnification, even if only a part of the image recorded on a film original is enlarged, the deterioration of image quality can be prevented or minimized. In addition, since a trimming region can be adjusted while confirming it through the monitor, a trimming job can be easily executed and trimming accuracy can be improved.

14 Claims, 9 Drawing Sheets

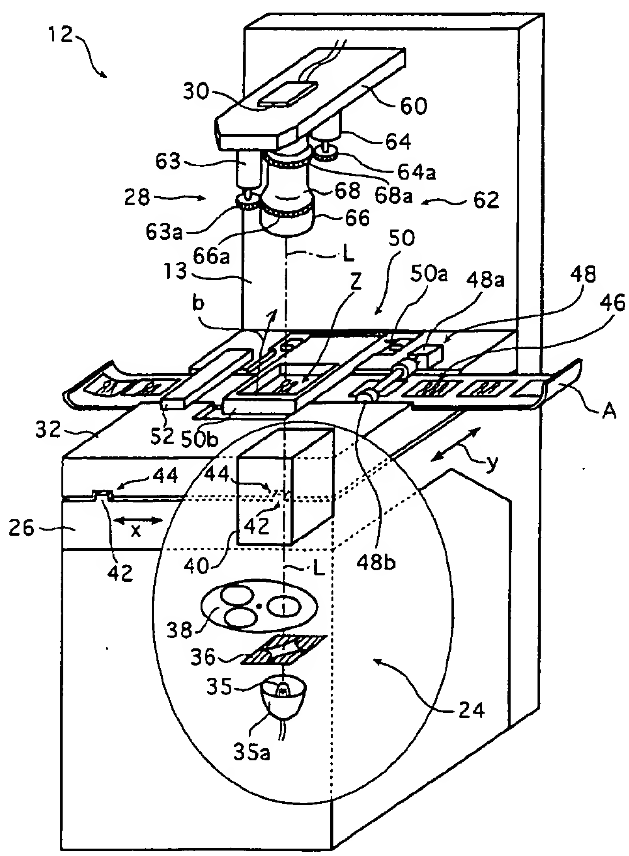


FIG.1

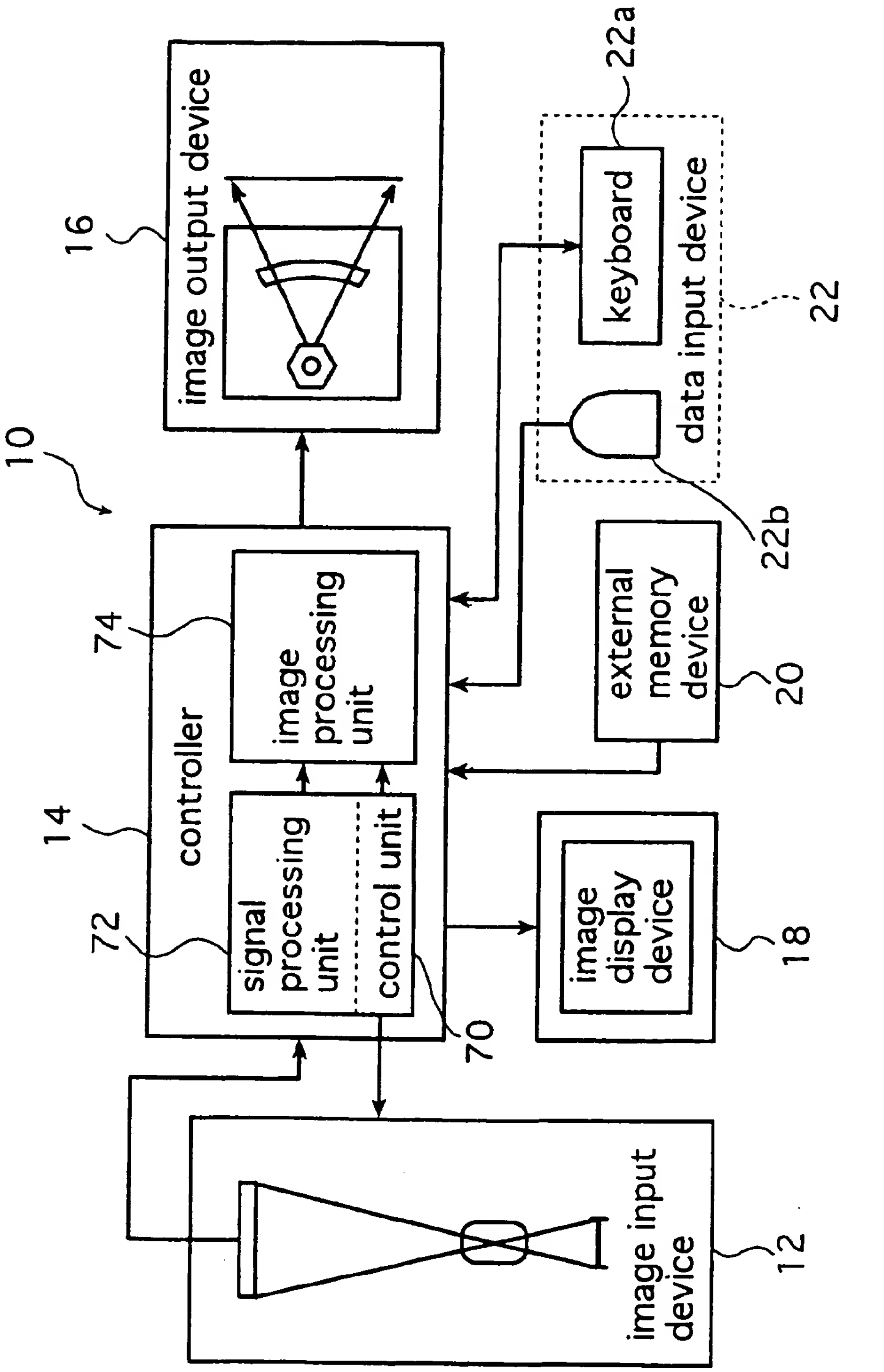


image output device
16
10
keyboard
22a
data input device
22
22b
external memory device
20
controller
14
image processing unit
74
signal processing unit
control unit
72
70
image display device
18
image input device
12

FIG. 2

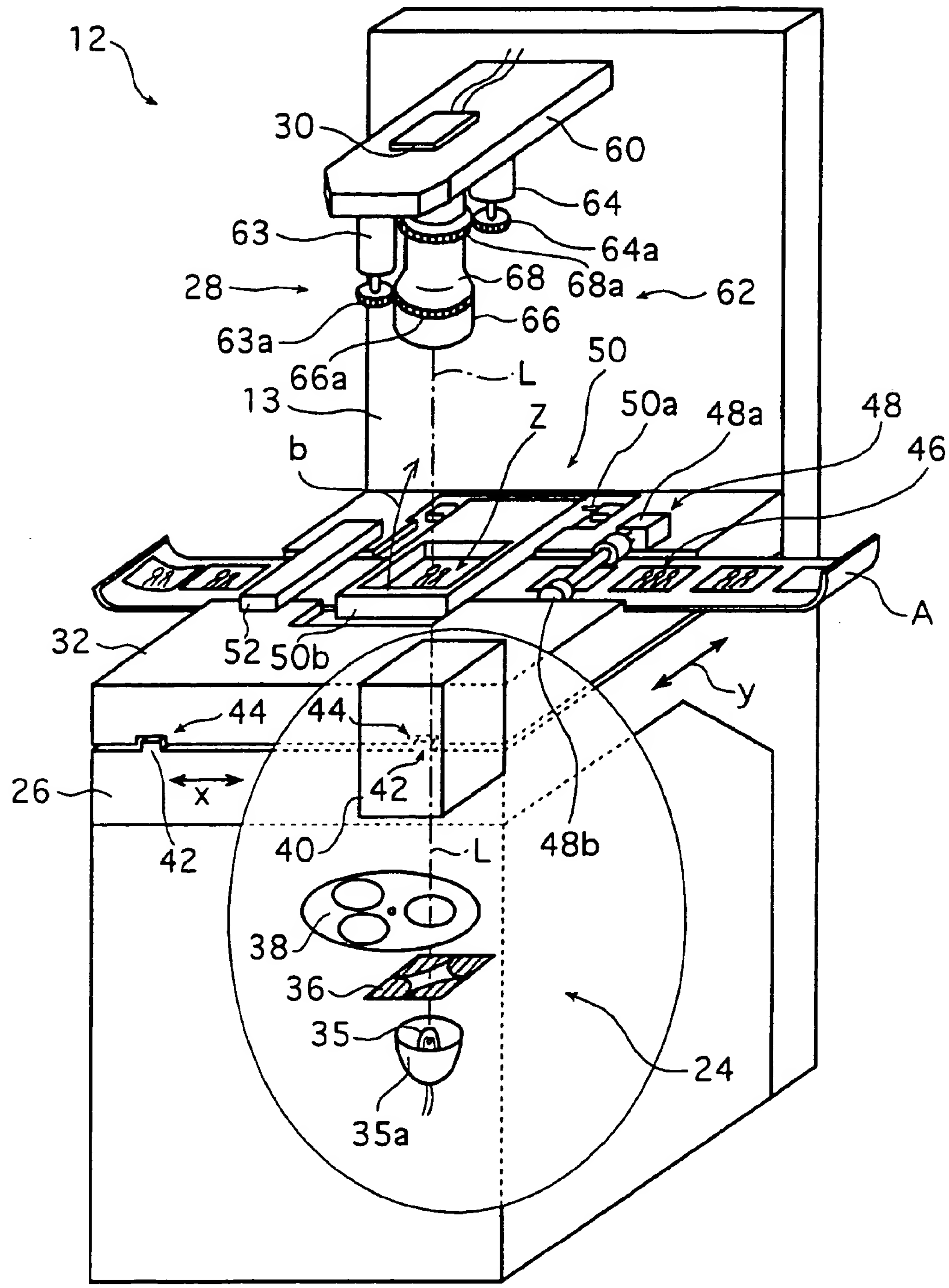

12
30
60
64
64a
63
68
68a
62
28
66
63a
66a
L
50
13
50a
48a
48
Z
46
b
A
32
52
50b
y
44
44
42
26
x
42
40
L
48b
42
38
36
35
24
35a

FIG. 3

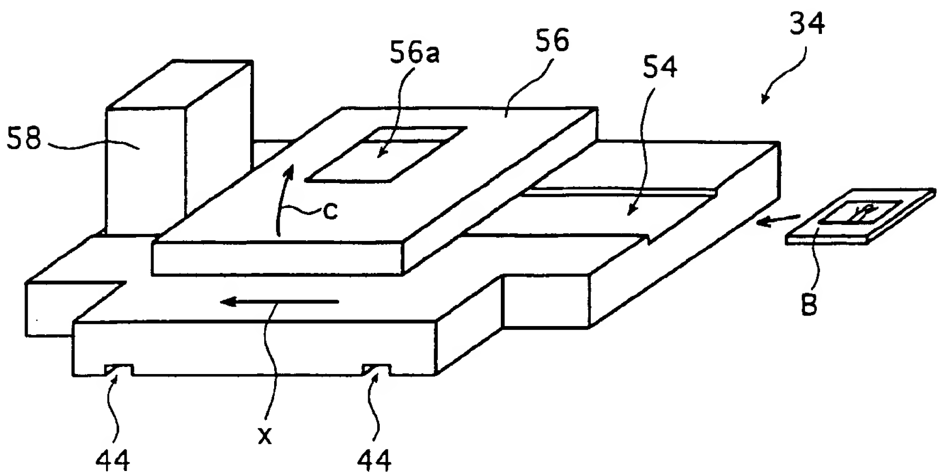


FIG. 4

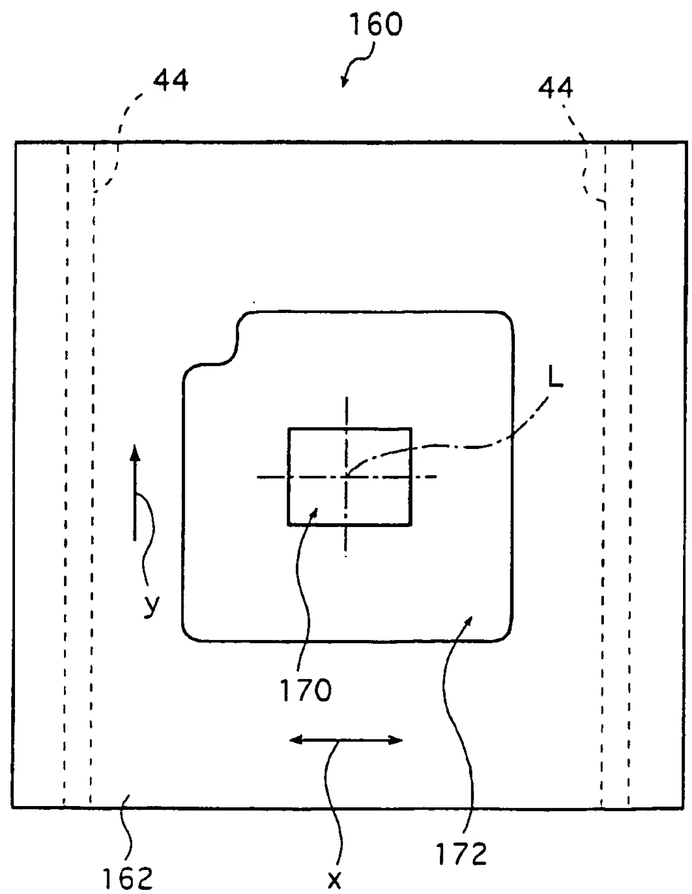


FIG.5

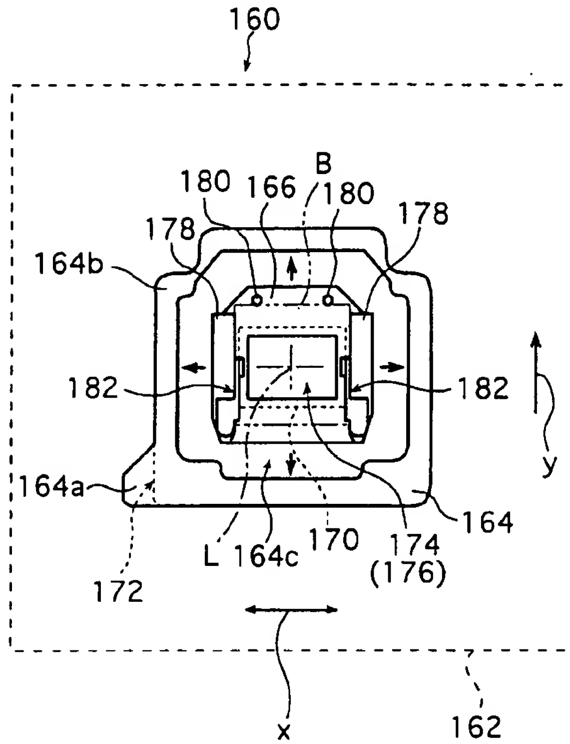

160
B
180
166
180
178
178
164b
182
182
y
164a
164
L
164c
170
174
(176)
172
x
162

FIG.6

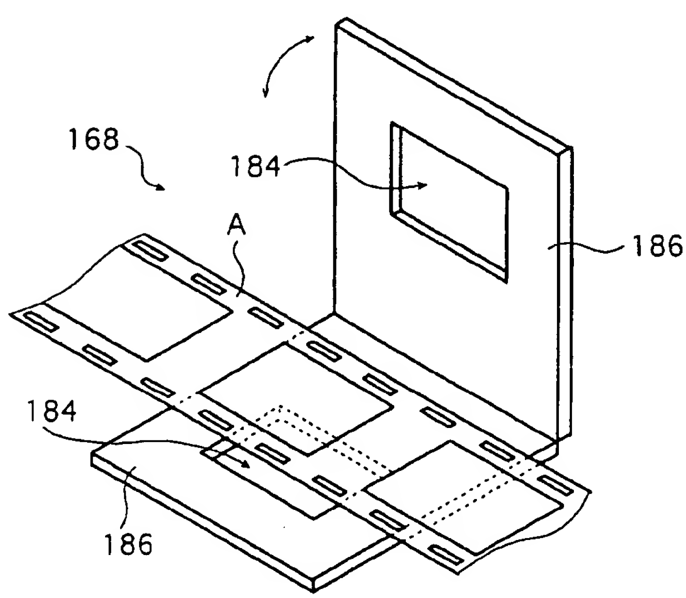

168
184
A
186
184
186

FIG. 7

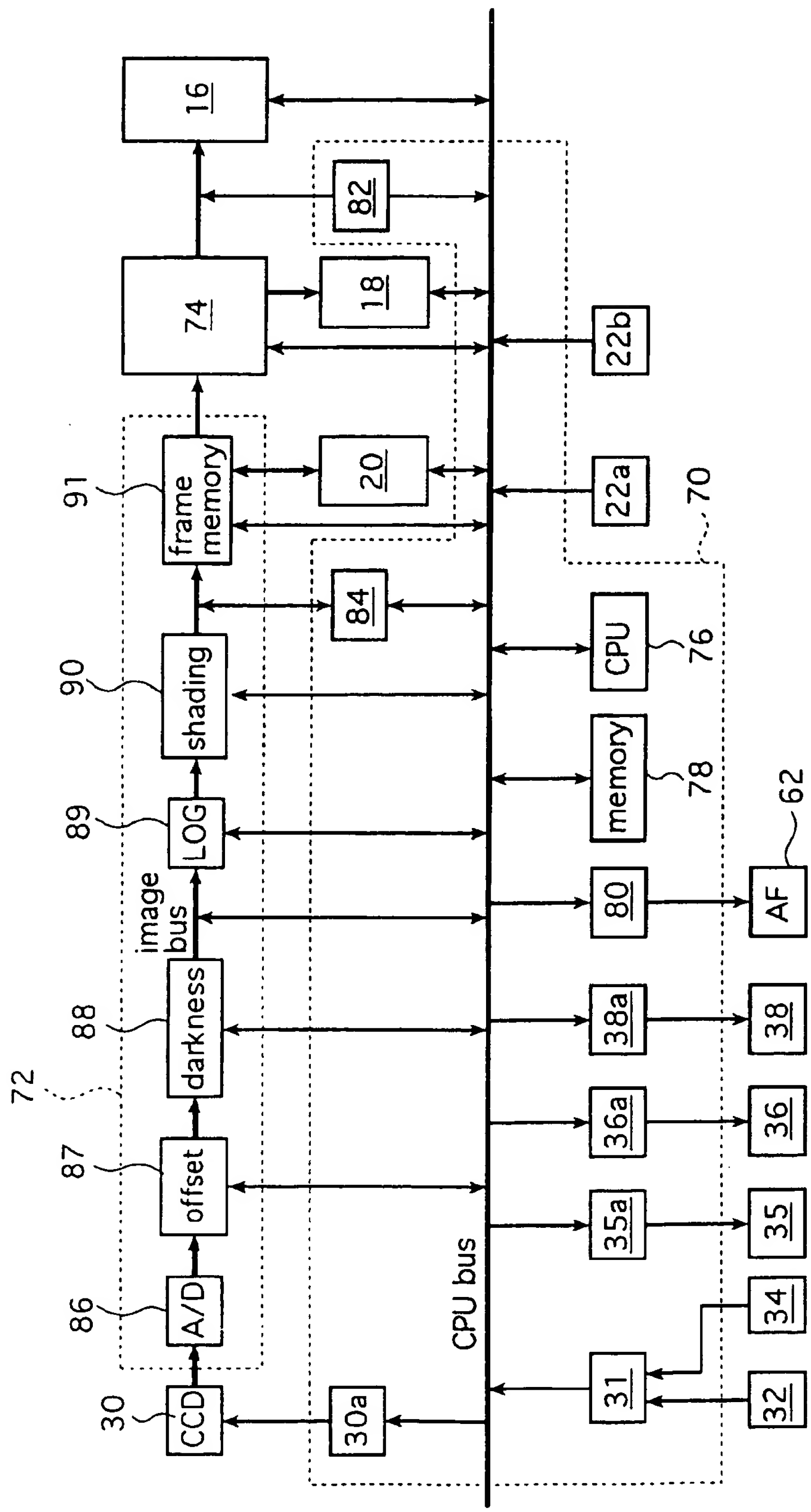
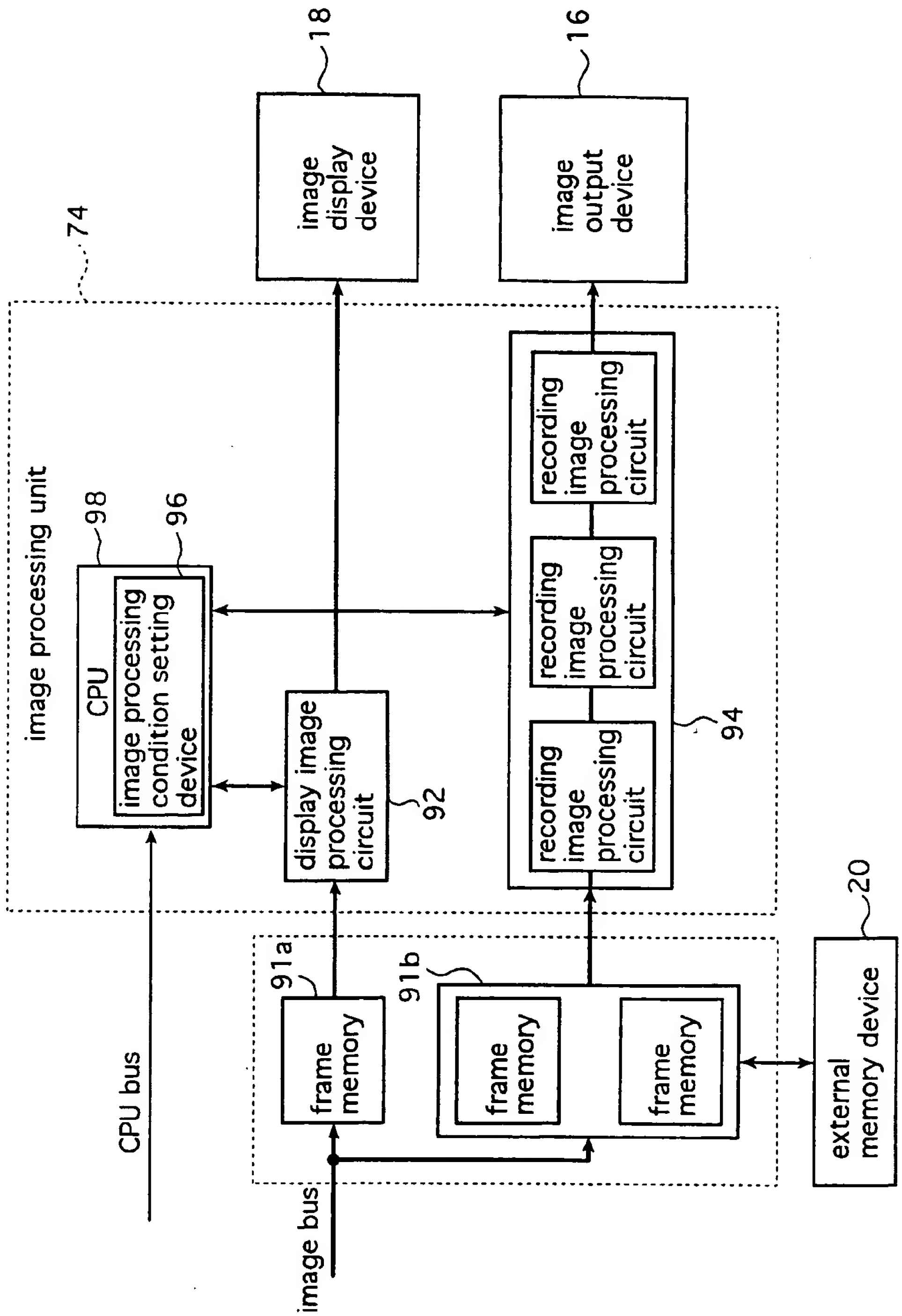

16
82
74
18
22b
91
frame memory
20
22a
70
84
90
shading
CPU
76
memory
78
89
LOG
image bus
80
AF
62
88
darkness
38a
38
72
87
offset
36a
36
35a
35
86
A/D
CPU bus
34
30
CCD
30a
31
32

FIG. 8



74
image processing unit
CPU
image processing condition setting device
98
96
display image processing circuit
92
recording image processing circuit
recording image processing circuit
recording image processing circuit
94
image display device
18
image output device
16
CPU bus
image bus
frame memory
91a
frame memory
frame memory
91b
external memory device
20

FIG. 9

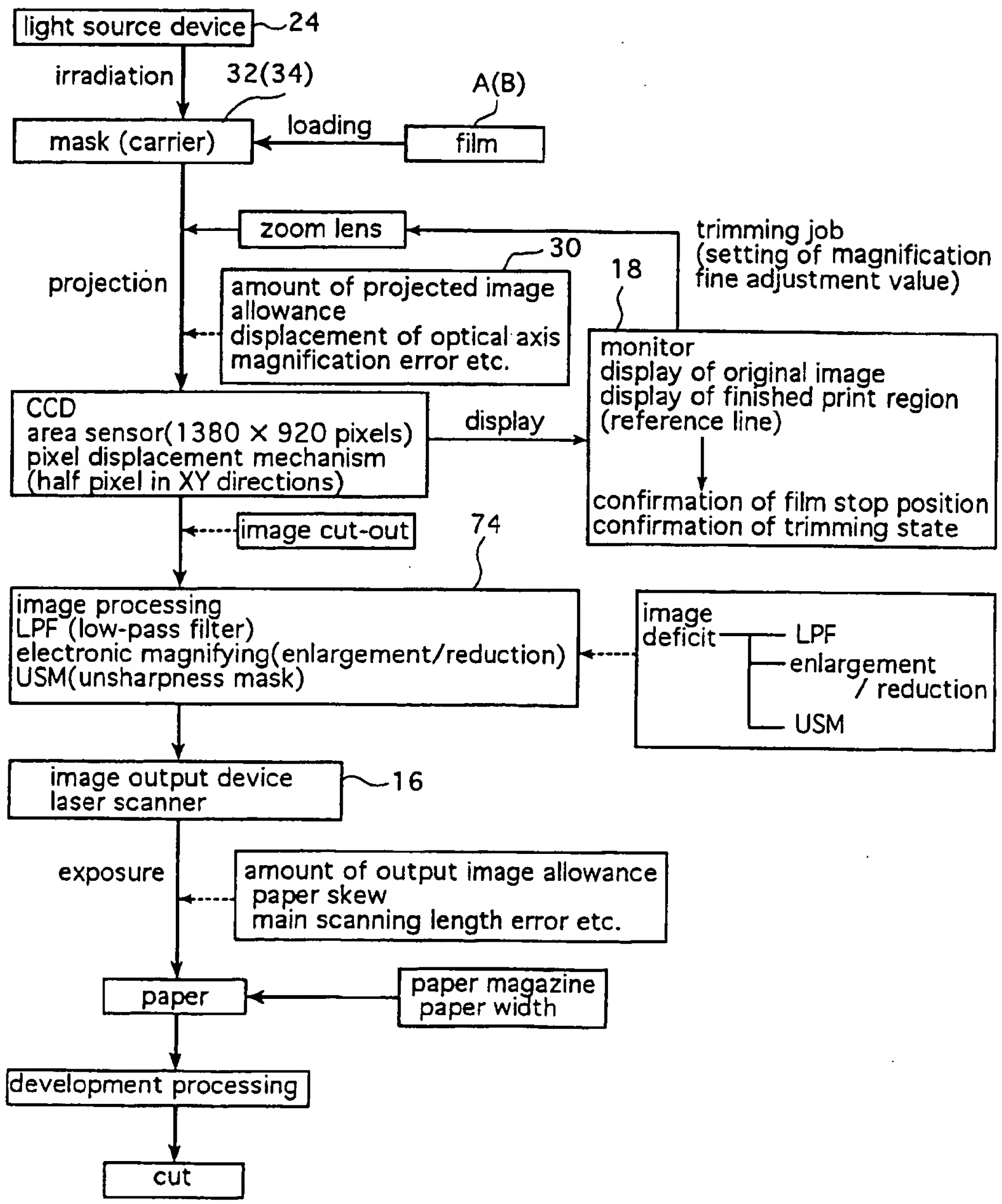

light source device
24
irradiation
32(34)
A(B)
loading
mask (carrier)
film
zoom lens
trimming job
(setting of magnification
fine adjustment value)
30
18
projection
amount of projected image
allowance
displacement of optical axis
magnification error etc.
monitor
display of original image
display of finished print region
(reference line)
CCD
area sensor(1380 × 920 pixels)
pixel displacement mechanism
(half pixel in XY directions)
display
confirmation of film stop position
confirmation of trimming state
image cut-out
74
image processing
LPF (low-pass filter)
electronic magnifying(enlargement/reduction)
USM(unsharpness mask)
image
deficit
LPF
enlargement
/ reduction
USM
image output device
laser scanner
16
exposure
amount of output image allowance
paper skew
main scanning length error etc.
paper
paper magazine
paper width
development processing
cut

FIG.10

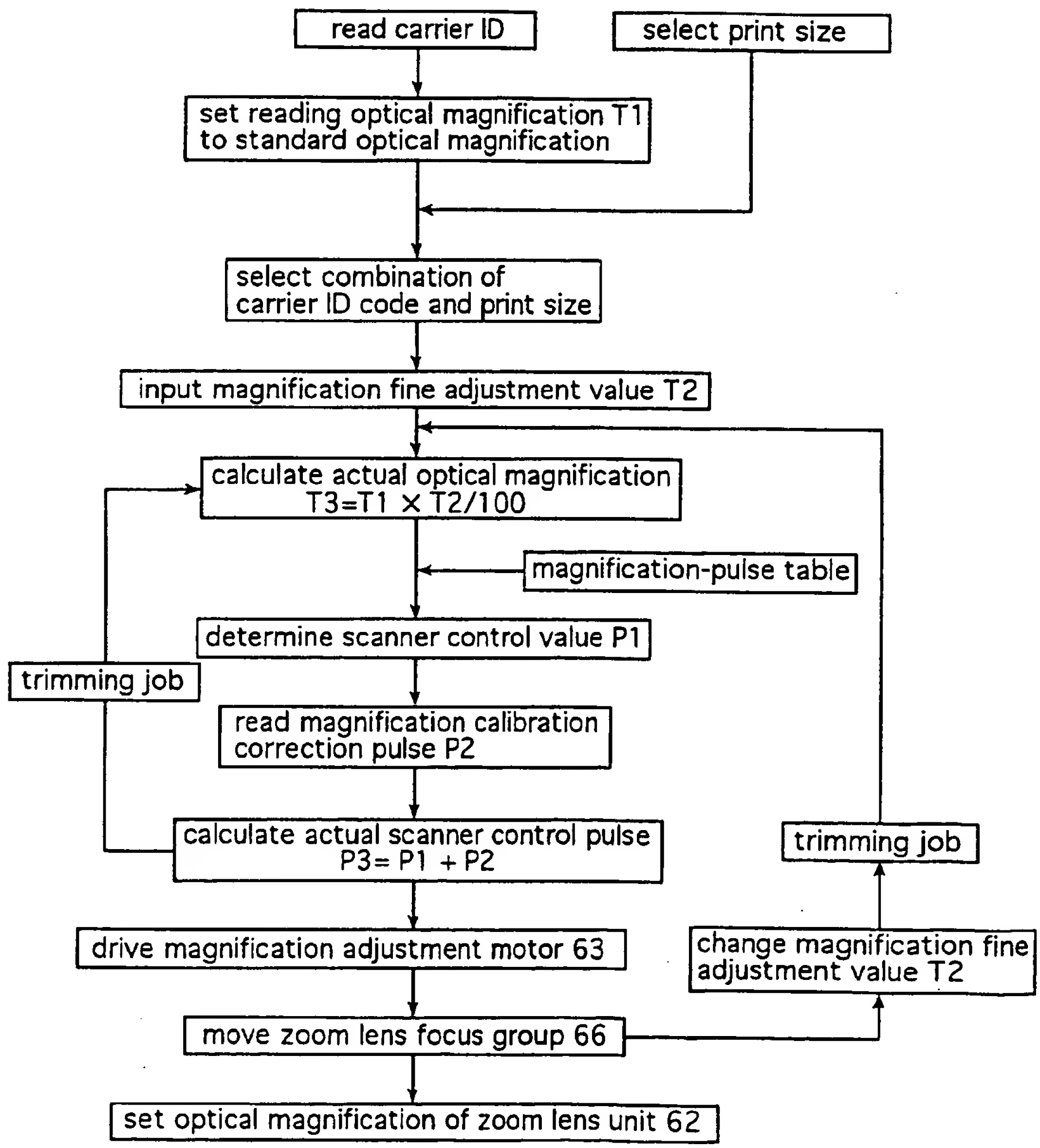
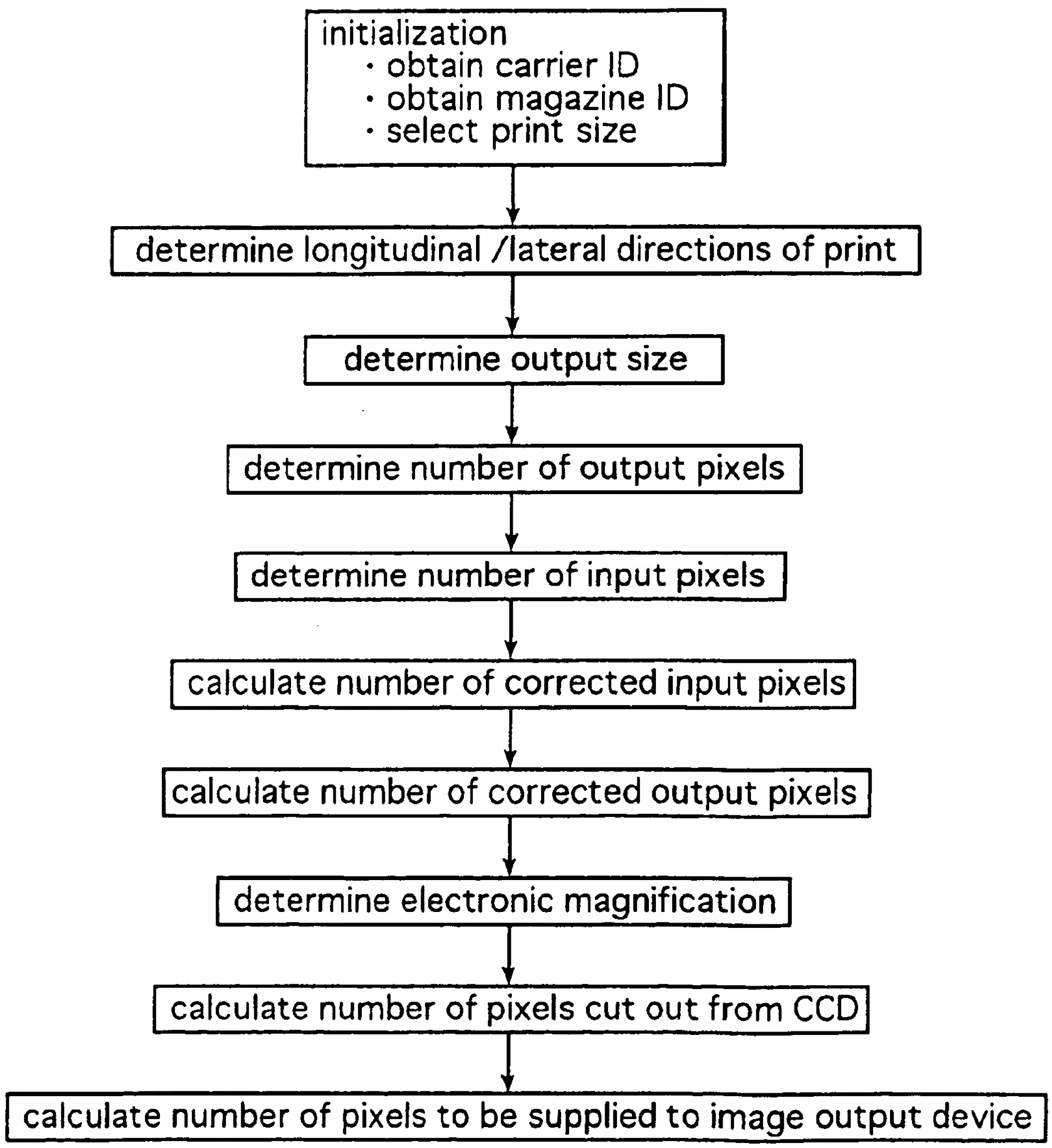

read carrier ID
select print size
set reading optical magnification T1 to standard optical magnification
select combination of carrier ID code and print size
input magnification fine adjustment value T2
calculate actual optical magnification T3=T1 × T2/100
magnification-pulse table
determine scanner control value P1
trimming job
read magnification calibration correction pulse P2
calculate actual scanner control pulse P3= P1 + P2
trimming job
drive magnification adjustment motor 63
change magnification fine adjustment value T2
move zoom lens focus group 66
set optical magnification of zoom lens unit 62

FIG. 11


initialization
· obtain carrier ID
· obtain magazine ID
· select print size
determine longitudinal /lateral directions of print
determine output size
determine number of output pixels
determine number of input pixels
calculate number of corrected input pixels
calculate number of corrected output pixels
determine electronic magnification
calculate number of pixels cut out from CCD
calculate number of pixels to be supplied to image output device

DIGITAL PRINT METHOD

BACKGROUND OF THE INVENTION

The present invention relates to a digital print method of obtaining prints of desired sizes regardless of the presence or absence of trimming by photoelectrically reading images of various sizes recorded on various types and sizes of film originals, subjecting the images to digital signal processing, trimming the images if necessary, and exposing a light-sensitive material using a light source such as a laser beam or the like.

Images recorded on photographic film originals (hereinafter, referred to as film originals or simply as films) such as negative films, reversal films and the like are conventionally printed onto light-sensitive materials such as photographic papers and the like by so-called direct exposure, that is, a method in which an image recorded on a film original is projected onto the light-sensitive material for area exposure.

In contrast, there have been recently proposed digital photoprint systems which make use of digital exposure. The apparatus photoelectrically reads image information recorded on a film, converts the thus read image into a digital signal and thereafter applies various steps of image processing to the digital signal to thereby provide recording digital image information. If these records the image (latent image) on a light-sensitive material by scan exposing it with recording light which is modulated in accordance with the image information, and produces a print through development. Digital photoprinters for embodying the above digital photoprint systems are under development.

The digital photoprint system can freely perform editing and layout jobs for print images such as composition of a plurality of images to a composite image, division of a single image into segments, editing of characters and images and the like and various types of image processing such as color/density adjustments, magnification adjustments, edge enhancement and the like and output finished prints which are freely subjected to editing and image processing in accordance with a specific use. Although conventional print systems employing the direct exposure cannot reproduce all the image density information recorded on a film and the like in such aspects as density resolution, space resolution, color/density reproducibility and the like, the digital photoprinter can output a print in which the image density information recorded on the film is almost perfectly reproduced.

Further, since the digital photoprint system can record (store) the image information of the images recorded on respective films and image processing conditions to the image information to a memory device provided with the system and an external memory device such as a floppy disc and the like, there is an advantage that extra printing and other jobs can be accomplished without any films that serve as originals. What is more, extra printing and other jobs can be performed in a rapid and efficient manner because processing conditions need not be set again.

Essentially, the digital photoprint system and the digital photoprinter under consideration are composed of an image input device for photoelectrically reading the image recorded on an original such as a film or the like through an image sensor or the like, a display device for displaying the thus read image, an image processing device for effecting image processing operations on the thus read image and determining exposing conditions for recording the image and an image recording device for obtaining a print to be subjected to a development process by scan exposing a light-sensitive material in accordance with the determined exposing conditions. The applicant invented various devices and methods for realizing such a digital photoprint system and proposed them in Japanese Unexamined Patent Publication Nos. 6-217091, 6-233052 and 6-245062, together with the disclosure of an outline of the digital photoprinter.

Incidentally, in the digital photoprint systems and digital photoprinters described above and proposed until now, an original image read by an image sensor is displayed on a display such as a monitor or the like. However, since there are various processes from the time the image born by a film original is read by the image sensor to the time the image is finally made to a print by being exposed and developed, the image region displayed on the screen of the monitor does not always match the reproduced image region in the print. Such mismatch also arises likewise when trimming is effected. Further, conventional digital photoprint systems have a problem that even if they can display a finished print region on a monitor, since they do not sufficiently take an image deficit that is, so-called "vignetting" caused in various processes into consideration, it cannot be said that the finishing region displayed on the monitor perfectly matches a print image region.

In addition to the problem of the mismatch, there are also problems that the periphery of an image born by the film original lies off the effective pixel region of an image sensor and a necessary peripheral portion of the image is lacking from a print. Further, since a projected image is smaller than the effective pixel region of the image sensor, an image signal having a sufficient number of input pixels cannot be obtained and a number of output pixels is increased by great enlargement effected by image processing. Thus, the image reproduced on a print is liable to appear out-of-focus and the degree of fineness of the quality of the print is deteriorated depending upon a method of projecting the film original to the image sensor. That is, depending upon, for example, how an optical magnification (optical enlargement/reduction) is set to determine a size of the projected image. This is because that film originals include various types and sizes such as, for example, the negative film, the reversal film and the like, a 135 size, a 240 size and the like, and even a film of the same size includes recorded images having various sizes such as, for example, a full size (F), a high-vision size (H), a panorama size (P) and the like. There arises another problem that if an optical magnification is fixed when an image born by the film original is trimmed, since the image is enlarged by image processing, there is a noticeable tendency that the image reproduced on a print is made to an out-of-focus state and the quality of the image is deteriorated. There is still another problem that the aforesaid various problems are more easily caused and difficult to be adjusted when images recorded on the same film original include a plurality of sizes in addition to that the film original to be handled has various types and sizes and when a digital photoprint system can arbitrarily set a plurality of finished print sizes regardless of the type and size of the film original and the size of a recorded image. Further, when the optical magnification is changed in accordance with the size of an image to be read in the above digital photoprint system to properly read the image born by the film original as much as possible, a further problem arises in that since images having different recorded sizes exist even in the film of the same size, the optical magnification and a focus must be adjusted each time the size of the recorded image to be processed changes even in the same film and productivity cannot be increased.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a digital print method capable of making a plurality of sizes of prints from a plurality of images of different sizes born by film originals having a plurality of different film sizes and reading by an image sensor any size of the images born by the film originals of any film size and the images in the trimmed regions of the film originals as much as possible when the images are trimmed, causing no deterioration of image quality to prints of any arbitrary size, capable of obtaining fine image quality through image processing effected using a minimum possible electronic magnification, having high reproducing accuracy of the film originals to the prints and further having high productivity by solving the above problems.

Another object of the present invention is to provide a digital print method capable of easily matching a trimmed image with the region within an image turning device **82**, negative/positive conversion device **84** and the like, easily confirming the matching state and easily and correctly performing a trimming job by displaying, together with an image read by an image sensor, a reference line in accordance with a print size on a monitor in order to show a finishing region in consideration of a pixel deficit caused by image processing and magnifying (enlarging/reducing) at least one of the read image and the displayed line.

To achieve the above objects, a digital print method of the present invention of projecting images having a plurality of image sizes and born by film originals having a plurality of film sizes through a zoom lens, photoelectrically reading the images by an image sensor, subjecting the thus read images to digital image processing, exposing a light-sensitive material based on a thus obtained digital image signal and subjecting the light-sensitive material to development processing so as to be able to obtain prints having reproduced images of a plurality of print sizes comprises the steps of displaying, when a print magnification is changed to output an image of a desired size to be read among the images born by one of the film originals as a print having a reproduced image of a desired print size, a reference line on a monitor together with the image born by the film original and read by the effective pixel region of the image sensor by changing at least one of an optical magnification and an electronic magnification, wherein the optical magnification projects the image of the desired size to be read of the film original into the effective pixel region of the image sensor, the electronic magnification is determined from an output pixel region determined from a desired print size in which the reproduced image is printed and an input pixel region determined from the effective pixel region of the image sensor in consideration of an image deficit caused by the digital image processing, and the reference line shows a cut-out pixel region which will be cut out from the effective pixel region based on the output pixel region and the electronic magnification in consideration of the image deficit as the finishing region of the print corresponding to the print size; setting, when no trimming is executed, the print magnification to a desired value by fixing the optical magnification to a value preset in accordance with the film size of the film original and changing the electronic magnification in accordance with the size of the image born by the film original; and setting, when trimming is executed, the print magnification to a desired value by switching between a case that the image of the desired size to be read is matched with the trimming region within the reference line by magnifying the image displayed on the monitor by giving preference to the change of the optical magnification executed by the operation of the zoom lens over the magnification of the region within the reference line executed by the change of the electronic magnification and a case that the trimming region is matched with the image of the desired size to be read by magnifying the region within the reference line displayed on the monitor by changing the electronic magnification rather than magnifying the image displayed on the monitor by changing the optical magnification while visually observing the image displayed on the monitor and the trimming region shown by the reference line showing the finishing region displayed thereon.

It is preferable that the print magnification is changed by changing the reading pixel density of the image born by the film original and read by the image sensor in accordance with the area or the length of the reproduced image of the print or the electronic magnification set at the time of the trimming.

It is preferable that when the trimming is executed, the print magnification is changed by giving preference to the optical magnification in a low print magnification in which the optical magnification can be changed by the operation of the zoom lens, whereas the print magnification is changed by fixing the optical magnification and changing the electronic magnification in the range in which the optical magnification cannot be changed by the operation of the zoom lens.

Further, it is preferable that when the trimming is executed, the print magnification is changed by the optical magnification or the electronic magnification depending upon the electronic magnification having been set.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of an embodiment of a digital print apparatus of the present invention for embodying a digital print method according to the present invention;

FIG. **2** is a schematic perspective view of an embodiment of an image input device of the digital print apparatus shown in FIG. **1**;

FIG. **3** is a schematic perspective view of an embodiment of a slide carrier used by the image input device shown in FIG. **2**;

FIG. **4** is a schematic plan view of the carrier main body of a trimming carrier used by the image input device shown in FIG. **2**;

FIG. **5** is a schematic plan view of the trimming carrier used by the image input device shown in FIG. **2**;

FIG. **6** is a schematic plan view of a strip holding plate used by the trimming carrier shown in FIG. **5**;

FIG. **7** is a block diagram of an embodiment of a controller of the digital print apparatus shown in FIG. **1**;

FIG. **8** is a block diagram of an embodiment of an image processing device of the controller shown in FIG. **1**;

FIG. **9** is a block diagram showing an example of the essential process of the digital print method according to the present invention;

FIG. **10** is a block diagram showing an embodiment of a method of determining an electronic magnification and a cut-out pixel region in the digital print method according to the present invention; and

FIG. **11** is a block diagram showing an embodiment of an optical magnification setting method in the digital print method according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

A digital print method according to the present invention will be described below in detail based on a preferable embodiment shown in the accompanying drawings.

FIG. 1 is a schematic block diagram showing an embodiment of a digital print apparatus for embodying a digital print method according to the present invention.

The digital print apparatus **10** shown in FIG. **1** includes an image input device **12** for photoelectrically reading the images having different image sizes which are born by film originals having different film sizes; a controller **14** for setting reading conditions for the image input device **12** and controlling the image input device **12** based on the reading conditions, and, in particular, setting, altering and adjusting an image sensor conversing magnification by changing an optical magnification, an electronic magnification and a reading pixel density in the present invention as well as determining a reading pixel region and a cut-out pixel region, subjecting a read image signal to image processing, automatically setting image processing conditions (auto-set-up) and the like; an image output device **16** for exposing an image to a light-sensitive material based on the image signal processed by the controller **14** and subjecting the light-sensitive material to development processing to thereby output a print on which the reproduced image is born; an image display device (monitor) **18** for displaying an original image read by the image input device **12** as well as the region of the image to be reproduced in accordance with the size of a print output by the image output device **16** and a trimming region; an external memory device **20** composed of a magnetic recording medium such as a server, a hard disc and the like, a magnetic optical recording medium or a magnetic tape and a floppy disc and the driver thereof, the magnetic recording medium storing the image signal of the original image read by the image input device **12**, the image signal processed by the controller **14** or used by the image output device **16** and further the image processing conditions, exposing conditions, light-sensitive material processing conditions and the like; and a data input device **22** such as a keyboard **22**a, a mouse **22**b and the like for setting various conditions such as an optical magnification, a print magnification, an image sensor converting magnification and the like, selecting various steps of processing and inputting information such as correction and the like.

The image input device **12** (hereinafter, referred to as an input device) shown in FIG. **2** is a device for photoelectrically reading images recorded on films as film originals which are different in type and size such as a strip as an elongated negative or reversal film on which a lot of images are recorded, a slide ordinarily composed of a single reversal film fixed to a frame (mount) and the like. The image input device **12** is essentially composed of an optical frame **13**, a light source section **24**, a carrier base **26**, an imaging unit **28** to which a zoom lens is assembled, an image sensor **30** as an area sensor, and a carrier such as a film carrier **32**, a slide carrier **34** (refer to FIG. **3**), a trimming carrier **160** (refer to FIG. **4**–FIG. **6**) and the like which are mounted on the carrier base **26** so as to be replaced each other.

In the image input device **12**, a strip A or a slide B is fed in an x direction in the figure by the film carrier **32** or the slide carrier **34** mounted on the carrier base **26** and stopped at a reading position Z, light from the light source section **24** is irradiated to the image on the film original, projection light bearing the image recorded on the film original is obtained, the projection light is projected onto the image sensor **30** at the imaging unit **28**, an image signal is obtained by subjecting the image to photoelectrical conversion and the image recorded on the film original is two-dimensionally read as the image signal. The image input device **12** is controlled by the input control unit **70** of the controller **14** which will be described later (refer to FIG. **4** and FIG. **5**).

The light source section **24** is used to produce light having respective colors for irradiating the film original (strip A and slide B), the light being uniformly dispersed and having a sufficient quantity of light to permit the image sensor **30** to decompose the image of the film original to the three primary colors R, G, B and read the image with a pinpoint accuracy. In the image input device **12** of the illustrated example, the light source section **24** which irradiates the strip A from downward of it to obtain the projection light is positioned below the carrier base **26** of the optical frame **13** and includes a light source **35**, a reflector **35**a, a stop **36**, a color filter plate **38** and a diffusion box **40**. Further, the light source section **24** is further provided with a cooling fan for cooling the various components such as the light source **35** and the like in addition to the above components and further may be provided with a shutter for shading the light emerging from the light source **35**, if necessary.

Various known light sources such as a halogen lamp, a xenon lamp, a mercury vapor lamp and the like which can emit reading light having a quantity which is sufficient for the image sensor **30** to read an image, may be utilized as the light source **35**.

The stop **36** is used to regulate the quantity of light from the light source **35** and the illustrated example uses two ND filters each having a logarithm-curved shielding portion and a different quantity of light passing at respective positions in a direction perpendicular to an optical axis L. A quantity of light to a film is regulated by causing the ND filters to come closer to or depart from each other in the direction perpendicular to the optical axis L.

The color filter plate **38** includes three color filters, namely, an R (red) filter, a G (green) filer and a B (blue) filter. When an image is read, the center axis of the color filter plate **38** is turned by not shown rotation means to thereby switch the color of a filter acting on the optical axis L and the R filter, the G filter and the B filter are sequentially inserted into the light passage L to thereby read the image recorded on the film original by decomposing it to the three primary colors of R, G, B.

The diffusion box **40** is used to diffuse the reading light which was emitted from the light source **35** and passed through the color filter with the quantity of light regulated by the stop **36** so that the quantity and other features of the reading light incident on the film is made uniform on a plane perpendicular to the optical axis L. In the illustrated example, the diffusion box **40** is composed of a quadrangular prism having internal specular surfaces and diffusion plates disposed on the upper and lower surfaces of the prism. However, various types of other known diffusion means other than the above may be used.

The carrier base **26** is disposed above the light source section **24** and provides a site on the upper surface thereof where the film carrier **32**, or the slide carrier **34**, a trimming carrier **160** and the like which will be described later are held at a specific position. The carrier base **26** is secured perpendicular to the optical frame **13**. The carrier base **26** has an opening (not shown) formed in an area corresponding to the optical axis L to permit the light emitted from the light source section **24** to pass therethrough. The opening is formed in accordance with the maximum image surface size of the film original which can be read by the light from the light source section **24** through the image sensor **30** in the image input device **12** so that the entire area of the maximum image surface can be sufficiently irradiated.

The carrier base **26** has guide rails **42**, **42** formed on the upper surface thereof in a direction away from the operator

toward the optical frame **13**, namely, in the direction of arrow y which is perpendicular to the direction of arrow x serving as a film feed direction. Grooves **44, 44** which are engaged with the guide rails **42, 42** are formed on the bottom surfaces of the film carrier **32**, the slide carrier **34** and the trimming carrier **160**. The position of each of the film carrier **32**, the slide carrier **34** and the trimming carrier **160** is regulated in the directions of arrow x and arrow y in such a manner that they are pushed in the direction of arrow y until their inner side ends are abutted against the optical frame **13** and fixed there with the grooves **44, 44** thereof engaged with the guide rails **42, 42** of the carrier base **26**. As a result, they are positioned at specific position on the carrier base **26** and fixed by a not shown lock mechanism.

These carriers **32, 34** can be removed from the carrier base **26** and very easily replaced with each other by being pulled toward the operator side so that the grooves **44, 44** thereof are drawn out from the guide rails **42, 42**. Note, as a means for mounting the film carrier **32**, the slide carrier **34**, the trimming carrier **160** and the like at the specific position on the carrier base **26** is not particularly limited.

The film carrier **32** feeds the elongated negative film or reversal film on which a lot of images are recorded, that is, the so-called strip (sleeve) A in the lengthwise direction thereof such that the respective image recorded on the strip A are sequentially fed to a specific position on the optical axis L, namely, the reading position Z corresponding to the not shown opening of the carrier base **26** for subsequent reading. The upper surface of the film carrier **32** is provided with a guide groove **46** in an area intersecting the optical axis L in the film feed direction shown by arrow x from a side of the film carrier **32** to the other side thereof. The guide groove **46** has substantially the same width as the strip A, which is fitted into guide groove **46** and fed with its lengthwise direction in agreement with the x-direction such that the respective images are sequentially fed to the reading position Z on the optical axis L. To this end, depth of the guide groove **46** is set such that the image plane (that is, the emulsion plane) of the strip A is at a specific position along the optical axis L (in the direction of focal depth).

An opening (not shown) is formed at the reading position Z of the film carrier **32** to permit the light from the light source section **24** to pass therethrough. This opening serves as a mask for determining the size of the image on the film original which is read by the image sensor **30** in the image input device **12**. The shape and size of the opening, that is, the size of the opening region of the mask is set to barely inscribe the size of the image plane so that the vignetting of an image is minimized in accordance with the image surface size of, for example, a **135** size strip A. The opening at the reading position Z of the film carrier **32** occupies a specific position which is different from that of the opening of the aforesaid carrier base **26** on the same optical axis L and it is needless to say that the light emitted from the light source section **24** and passed through the opening of the carrier base **26** can sufficiently irradiate the entire opening of the film carrier **32** even if the film original loaded thereon has any image surface size. Therefore, the light emitted from the light source section **24** and regulated by the mask can sufficiently irradiate the entire image surface size of the original image which can be read by the image input device **12**. Note, the opening formed in the film carrier **32** may be set to a size corresponding to the opening of the carrier base **26** and a mask may be replaced so as to correspond to various sizes and mounted on the film carrier **32**.

The guide groove **46** is fitted with feed device **48** for feeding the strip A, a film compressing unit **50** and an image plane detecting sensor **52** which are arranged in that order from an upstream side to a downstream side in the x-direction.

The feed device **48** is composed of a motor **48a** and feed rollers **48b** and intermittently feeds the strip A in the x-direction. When the result of detection with the image plane detecting sensor **52** for detecting a recorded image and the DX code shows that an image of the strip A has come to the reading position Z, the feed device **48** stops feeding the strip A, and upon receiving a READ END signal from the controller **14**, the feed device **48** resumes the feed of the strip A until a subsequent image is fed to the reading position Z.

The film compressing unit **50** compresses the strip A disposed at the reading position Z against the guide groove **46** when the image is read by turning a compressing member **50b**, to which an opening is formed to permit the projection light of the strip A to pass therethrough, about a rotating shaft **50a** in the direction opposite to arrow b so that the curls and other habits of the strip A are eliminated. This insures that the entire image surface is held at a specific position along the optical axis L, that is, at the position where the original is disposed.

Note, the feed of the strip A executed by the film carrier **32** and the operation of the film compressing unit **50** are not limited to the aforesaid arrangement in which they are automatically controlled by the use of the image plane detecting sensor **52** and the like. For example, they may be semi-automatically controlled or the operator may manually turn the compressing member **50b** and/or stop and drive the feed device **48**.

The slide carrier **34** shown in FIG. **3** is mounted on the carrier base **26** in place of the film carrier **32** shown in FIG. **2**. The slide carrier **34** feeds the so-called slide B which is composed of a film having an image recorded thereon and held by a frame in the direction of arrow x, stops it at the reading position Z for subsequent reading and collects the slide B whose image having been read.

The upper surface of the slide carrier **34** is provided with a guide groove **54** for guiding the slide B in an area intersecting the optical axis L in the slide B feed direction shown by arrow x from a side of the slide carrier **34** to the other side thereof. The depth of the guide groove **54** is set such that the image plane of the slide B is at a specific position substantially along the optical axis L (in the direction of focal depth). Further, the slide carrier **34** has an opening formed at the reading position Z likewise the film carrier **32**, the opening serving as a mask for permitting the light from the light source section **24** to pass therethrough. Note, a mask may be arranged as an independent member likewise the film carrier **32** and replaced in accordance with a size of the slide B.

A cover **56** is disposed on the upper surface of the slide carrier **34** in the vicinity of the reading position Z. The cover **56** has a through-hole **56a** formed in the upper surface thereof to permit the projection light of the slide B to pass therethrough. The cover **56** covers the slide B located at the reading position Z in a normal reading mode but it can open the reading position Z by being turned in the direction of arrow c in the drawing, if necessary. The guide groove **54** which is a little wider than the slide B is formed below the cover **56**, sensors are disposed in the inlet of the guide groove **54** and in the vicinity of the reading position Z thereof to detect the extreme end of the slide B which is inserted by the operator or automatically fed by the feed device. Further, a plurality of rollers, for example, six rollers are disposed on each side of the widened portion of the guide

groove **54** to feed the slide B. The upper rollers are composed of feed rollers which are rotated at a specific speed by a not shown drive source to feed the slide B and the lower rollers are composed of follower rollers which can urge the slide B upward by an urging device such as springs or the like. Note, a slide presser may be disposed at the reading position Z to press the slide B against the guide groove **54** at the extreme end thereof to correct the distortion and floating of the slide B (the frame thereof) when it is read, if necessary.

A slide recovery box **58** is disposed downstream of the cover **56** (in the direction of arrow x) to recover slides B for which the reading operation has ended. The slide recovery box **58** of the illustrated example is arranged to recover each slide B by causing it to be slid under the already recovered slide B. The slides B having been read are collected by being sequentially laminated from a lower side. Note, the slide recovery box **58** may be a box which accommodates slides B dropped by being pushed by the following slide B fed thereafter or the like in addition to the above.

The trimming carrier **160** shown in FIG. **4** to FIG. **6** is used by being mounted on the carrier base **26** in place of the film carrier **32** shown in FIG. **2** or the slide carrier **34** shown in FIG. **3**. This is a carrier for effecting trimming by holding the strip A or the slide B at an arbitrary position and cutting out and enlarging the image of the strip A or the slide B at an arbitrary position thereof. The trimming carrier **160** includes a carrier main body **162** (refer to FIG. **4**), a base **164**, a slide holding plate **166** (refer to FIG. **5**) and a strip holding plate **168** (refer to FIG. **6**) which is used in place of the slide holding plate **166**.

As shown in FIG. **4**, the carrier main body **162** is a rectangular member having an outside shape which is similar to that of the carrier main body of the film carrier **32** and has the grooves **44, 44** formed on the bottom surface thereof in correspondence to the guide rails **42, 42**. The carrier main body **162** has a through-hole **170** formed therethrough which permits the reading light from the light source section **24** to pass through it. Further, the carrier main body **162** has a recess **172** which is recessed from the upper surface thereof with the through-hole **170** positioned substantially at the center thereof and the base **164** is loosely inserted into the recess **172** and mounted thereon.

As shown in FIG. **5**, the base **164** is composed of a sheet-shaped member mounted on the carrier main body **162** by being loosely inserted into the recess **172** of the carrier main body **162** and has a grip **164*a*** which projects from the recess **172** to the outside when base **164** is mounted on the carrier main body **162** (recess **172**) to permit the base **164** to be easily mounted and dismounted. Further, the base **164** has an opening **174** formed substantially at the center thereof to cause the reading light from the light source section **24** of the image input device **12** to pass therethrough.

The base **164** is formed into such a dish-shape that the upper surface thereof other than a peripheral section **164*b*** is formed into a recessed placing section **164*c*** so that the slide holding plate **166** can be movably placed thereon.

The slide holding plate **166** is a sheet-shaped member having a mask opening **176** formed thereinto in correspondence to the image surface of the slide B (shown by a two-dot-and-dash-line in FIG. **5**), holds the slide B and is movably placed on the placing section **164*c*** of the base **164** as described above. Therefore, the upper surface of the slide holding plate **166** is formed into such a height that when the slide holding plate **166** is placed on the placing section **164*c*** with a standard slide B placed thereon, the film surface of the holding plate **166** is located at a specific position in the optical axis L.

Regulating members **178, 178** and abutting sections **180, 180** are fixed on the upper surface of the slide holding plate **166** and further a presser member **182** is attached to each of the regulating members **178**.

Note, a lubricating member such as a teflon sheet or the like may be disposed in the back surface of the slide holding plate **166**, the upper surface of the placing section **164*c*** or both the surfaces thereof or various types of lubricating processing may be applied thereto to enable the slide holding plate **166** to smoothly move on the placing section **164*c***.

The regulating members **178, 178** are composed of approximately quadrangular-prism-shaped guide members positioned across both the short sides of the opening **176** and extending in the same direction as the short sides and regulate the positions of the confronting end surfaces of the slide B. Therefore, an interval between the regulating members **178** is set in accordance with the maximum size of a slide B which is anticipated to be mounted.

The abutting sections **180, 180** are projections disposed on the upper surface of the slide holding plate **166** in the vicinity of the inner end surface thereof and regulate the inner end surface of the slide B which is perpendicular to the end surfaces regulated by the regulating members **178**.

That is, the slide B is inserted between the regulating members **178, 178** in the direction of arrow y until it is abutted against the abutting sections **180, 180** and the position thereof is regulated so that the entire image surface thereof is positioned on the opening **176**.

The presser members **182** are pivoted on the inside surfaces of the regulating members **178** so as to turn upward and downward (vertical direction on the sheet of FIG. **5**) as well as the ends on the abutting sections **180** side thereof are urged downward so that they are abutted against the upper surface of the slide holding plate **166** and press it. Therefore, the slide B inserted between the regulating members **178** is held by being pressed against the slide holding plate **166** by the presser members **182**.

In the illustrated example, the slide B is placed on the slide holding plate **166** in the direction where the image surface thereof is matched with the opening **176**, inserted between the regulating members **178, 178** from the side opposite to the abutting sections **180, 180** until it is abutted against the abutting sections **180, 180** and fixed by being pressed against the slide holding plate **166** by the presser members **182**. Since the slide holding plate **166** is movably placed on the placing section **164*c*** of the base **164**, any arbitrary area of the image of the slide B can be positioned to the optical axis L by moving the slide holding plate **166** in four directions as shown by arrows in FIG. **5**.

Although described in detail later, since the imaging unit **28** of the image input device **12** is provided with a zooming function, it can enlarge the projected image of the slide B imaged on the image sensor **30** about the optical axis L and trim any arbitrary area of the image of the slide B of the slide B by positioning a desired area of the image to the optical axis L and adjusting a magnification.

The trimming carrier **160** shown in FIG. **4** and FIG. **5** is a trimming (slide) carrier using the slide holding plate **166** for holding the slide B. However, as shown in FIG. **6**, a strip holding plate **168** for clamping the strip A which is composed of two plate members **186, 186** turnably joined to each other by a hinge and have openings **184** corresponding to the image portion of the strip A may be used in place of the slide holding plate **166**. When the strip holding plate **168** is placed on the placing section **164*c*** of the base **164**, it may be used as a trimming (strip) carrier for trimming any arbitrary area of the image recorded on the strip A.

Note, it is preferable in the present invention that the carrier for disposing the film original in the reading position is arranged as a replaceable carrier which corresponds to each film original having a different type and a different size and any carrier may be used so long as it has an opening formed at the reading position Z thereof to cause the light from the light source section 24 to pass therethrough and grooves formed therein so that they are engaged with the guide rails 42, 42, in addition to the aforesaid film carrier 32 and slide carrier 34 for automatically or semi-automatically feeding the strip A and the slide B to the reading position Z and the trimming carrier 160 for executing trimming. Further, a manual film carrier for permitting the operator to fix the film original at a specific position, a manual slide carrier for feeding the slides B supplied by the operator in the direction of arrow x one by one, stopping them at the reading position Z for reading images and recovering the slides B whose images have been read, and the like may be also employed.

These carriers are provided with a carrier ID code and when they are mounted on the carrier base 26 of the optical frame 13 and electrically connected, the carrier ID code is transmitted to the controller 14.

The imaging unit 28 for imaging the projection light of the strip A and the slide B to the image sensor 30 is disposed in the upper portion of the optical frame 13. The imaging unit 28 includes a zoom lens unit 62, a magnification adjustment motor 63 and a focus adjustment motor 64 which are vertically disposed to a level block 60 fixed to the optical frame 13. The zoom lens unit 62 includes a zoom lens group 66 and a focus lens group 68. The zoom lens group 66 has a known zoom lens assembled thereto which changes an optical magnification in accordance with the size and trimming size of the strip A and the slide B and images the projection light to the image sensor 30 by adjusting the size thereof to a maximum size which can be received by the image sensor 30 (that is, a size which permits a necessary image region to inscribe or nearly inscribe the light receiving surface of the image sensor 30). The focus lens group 68 is positioned above the zoom lens group 66 (downstream in the direction of the optical axis L) and has a known focus adjusting lens assembled thereto which adjusts the focus of the projection light on the light receiving surface of the image sensor 30.

Since the adjustment gear 66*a* of the zoom lens group 66 is meshed with a gear 63*a* rotated by the magnification adjustment motor 63 serving as a zooming motor, the movement of the zoom lens group 66 in the direction of the optical axis L is adjusted by the magnification adjustment motor 63 so that the projection light having a size in accordance with an inherent standard optical magnification or an optical magnification set by a method of the present invention is imaged on the image sensor 30. The magnification adjustment motor 63 is driven in an amount determined by a magnification-pulse table stored in a memory 78. Further, since the adjustment gear 68*a* of the focus lens group 68 is meshed with a gear 64*a* rotated by the focus adjustment motor 64, the focus of the focus lens group 68 is adjusted by focus adjustment motor 64, that is, it is moved to a focusing position. The focus adjustment motor 64 is driven by being controlled by the automatic focus adjustment device 80 of the controller 14 and the image input device 12 of the illustrated example executes automatic focus adjustment (automatic focusing: AF) by a TTL (through the lens) system using the image read by the image sensor 30 and the contrast thereof. Note, a temperature sensor such as, for example, a thermistor or the like may be attached to the imaging unit 28 for correcting the variation of the focus position of the zoom lens unit 62 caused by the variation of a lens temperature.

The projection light of the strip A and the slide B is imaged on the image sensor 30 by the zoom lens unit 62 and photoelectrically read. Note, a known shutter used to dark current correction and the like may be interposed between the zoom lens unit 62 and the image sensor 30.

In the image input device 12 for two-dimensionally reading an image, the image sensor 30 is an area sensor such as, for example, a CCD sensor having 1380×920 pixels. Further, in the apparatus of the illustrated example, the image sensor 30 is adapted to be movable in both the x- and y-directions by an amount corresponding to half a pixel and this increases the apparent number of reading pixels (reading pixel density) by a factor of up to four.

The image input device 12 is essentially arranged as described above.

The signal from the image sensor 30 is supplied to the controller 14.

As shown in FIG. 1, the controller 14 includes a control unit 70 for controlling the respective sections and the entire section of the image input device 12 and the digital print apparatus 10 of the present invention, a signal processing unit 72 for receiving the signal output from the image sensor 30 of the image input device 12, subjecting the signal to specific signal processing and making the signal to an input image signal, and an image processing unit 74 for subjecting the thus obtained image signal to required or desired image processing and supplying it to the image output device 16 as an output image signal.

The control unit 70 includes a CPU 76, the memory 78, the automatic focus adjustment means 80, image turning control means 82, a negative/positive conversion circuit 84 and the like. The CPU 76 controls not only the signal processing calculation executed by the signal processing unit 72 but also the respective sections and the entire section of the image input device 12 as well as sets and adjusts the optical magnification through the zoom lens and an electronic magnification through image processing in the method of the present invention and changes an image sensor conversion magnification by changing the reading pixel density, if necessary. The memory 78 stores reading optical magnification information, zoom lens moving amount information, image sensor information, carrier information, output pixel density information, print size information, magazine information, amount of output vignetting allowance information, I/O pixel deficit information and the like. The automatic focus adjustment device 80 executes automatic focus adjustment using the image read by the image sensor 30. Further, connected to the control unit 70 are the keyboard 22*a*, the mouse 22*b*, the monitor 18 and the like. The keyboard 22*a* and the mouse 22*b* instruct the operation of the image input device 12, set reading conditions such as the reading optical magnification, print magnification, image sensor conversion magnification (presence or absence of pixel displacement) and the like, input a print size (size of an output image) and a main subject and indicate color/density correction and the like. The monitor 18 displays the image read by the image sensor 30 and a reference line showing the finishing region of a print.

FIG. 7 shows a detailed block diagram of an embodiment of the control unit 70 and the signal processing unit 72. In the control unit 70, the image sensor (CCD) 30 is connected to a CPU bus through an x - y direction movement control

circuit **30***a* to displace pixels to increase the apparent number of the reading pixels (density). The image information read by the CCD **30** is supplied to the signal processing unit **72**. In the signal processing unit **72**, the analog image data read by the image sensor **30** is converted into digital image data by an A/D converter **86**, subjected to DC offset correction by an offset correction circuit **87** and then subjected to darkness correction by a darkness correction circuit **88**. Thereafter, the thus processed image data is subjected to logarithmic transformation by a logarithmic transformation circuit **89** and subjected to shading correction by a shading correction circuit **90** and made to an input image signal which is stored in a frame memory **91** and supplied to the image processing unit **74**.

The image data subjected to the darkness correction by the darkness correction circuit **88** is supplied to the automatic focus adjustment device **80**. The automatic focus adjustment device **80** first moves the zoom lens unit **62** to respective points spaced apart from each other at specific intervals in a specific search area by controlling the focus adjustment motor **64** to thereby obtain image data subjected to the darkness correction at the respective points and determine an integrated image contrast value. A position where the integrated image contrast value is maximized is determined as a focused position by repeating the above operation and the zoom lens unit **62** is set to the focused position by controlling the focus adjustment motor **64** through the CPU bus.

Carrier ID discrimination means **31** supplies the carrier ID code of any one of the film carrier **32** for the strip A, the slide carrier **34** for the slide B and the trimming carrier **160** being mounted to the CPU **76**, the memory **78** and the automatic focus adjustment device **80** through the CPU bus and the keyboard **22***a* and the mouse **22***b* supply information such as reading conditions including the registered print size, reading optical magnification, their adjusted values and the like which were supplied, selected, added or corrected, recording conditions including color and/or density correction, dodging correction, gradation correction, and the like thereto through the CPU bus.

Note, the light intensity of the light source **35** of the light source section **24**, the degree of opening of the stop (iris stop) **36** and the type of the filters of the color filter plate **38** are controlled, respectively by a light source control circuit **35***b*, a stop control circuit **36***a* and a color filter control circuit **38***a* which are connected thereto through the CPU **76** and CPU bus.

According to the method of the present invention, essentially, the CPU **76** selects and reads out a standard optical magnification stored in the memory **78** in accordance with the carrier ID code supplied from the carrier ID code discrimination means **31**, calculates an adjusted optical magnification from a standard optical magnification selected in accordance with the adjusted value of the set optical magnification of the zoom lens unit **62** which was supplied from the data input device **22** with respect to the combination of the carrier ID code (type and size of a film original and mask size) and a print size and calculates an amount of movement (a number of pulses) corresponding to the adjusted optical magnification calculated from a table (LUT) representing, for example, the relationship between the optical magnification stored in the memory **78** and the amount of movement of the zoom lens group **66** of the zoom lens unit **62**, that is, the number of pulses applied to the magnification adjustment motor **63**.

The CPU **76** determines an output size and an output pixel region (a number of pixels) from the print size, amount of output vignetting allowance, output pixel density and the like which are stored in the memory **78** as well as an input pixel region (a number of pixels) from the effective pixel region (the number of pixels) of the image sensor **30** stored in the memory **78**, a mask opening region and the like, calculates the electronic magnification from these I/O pixel regions and the I/O pixel deficit (a number of pixels) stored in the memory **78**, determines a cut-out pixel region (a number of pixels) from the effective pixel region of the image sensor **30** using these determined factors and thereafter corrects the output pixel region again by the cut-out pixel region.

According to the present invention, the CPU **76** essentially acts to use both an optical magnification and an electronic magnification (electronic enlargement/reduction) when it changes a print magnification. However, since an emphasis is put on productivity in an ordinary digital print in which no trimming job is executed, even if images recorded on the film having the same film size have different sizes, for example, even if images having a full size (F), a high-vision size (H) and a panorama size (P) are mixedly recorded on a 135 film, the same optical magnification is fixedly used to the film of the same type and the same size, that is, to the film to which the same carrier is used and changes the electronic magnification each time a print size changes. On the other hand, when the trimming job is executed, the CPU **76** realizes a print with less deterioration of image quality by giving precedence to the optical magnification over the electronic magnification by putting greater emphasis on trimming accuracy and image quality than the productivity. However, when the print magnification is less changed by the trimming in the trimming job and emphasis is put on the productivity or when the optical magnification cannot be employed, the CPU **76** gives precedence to the electronic magnification over the optical magnification.

The CPU **76** determines whether pixel displacement is to be executed or not to change the reading pixel density, that is, the pixel density (pitch) of the image sensor **30** in order to output a print having good image quality based on the reproduced image area of the print and a print length, and in particular based on the electronic magnification in trimming.

Note, the print magnification is given as the product of the optical magnification, the electronic magnification and the image sensor conversion magnification. The print magnification represents the magnification of the print size of the reproduced image of an output print to the image size of the film original. The optical magnification represents the magnification of the size of an image projected onto the image sensor **30** by the zoom lens unit **62** to the image size of the film original. The electronic magnification represents the magnification of the number of output pixels (region) to the number of input pixels (region)in consideration of the vignetting caused by the image processing. The image sensor conversion magnification represents the magnification of the output pixel density of the print to the pixel density of the image sensor **30**.

The memory **78** stores various information necessary to control the operation of the digital print apparatus **10** of the present invention, the information including carrier information such as the ID code of a carrier mounted on the carrier base **26**, the mask size (size information in main- and sub-scanning directions) of the carrier, the size and type of a film set to the carrier, and the like; reading optical magnification information such as a magnification-pulse table showing the position of the zoom lens group **66** of the zoom lens unit **62** (an amount of movement from a home

position HP, that is, a number of pulses applied to the magnification adjustment motor 63) which corresponds to the carrier ID code and the standard optical magnification and the set optical magnification corresponding to the carrier ID code; image sensor information such as the size (size information in main- and sub-scanning directions), pixel density, effective pixel region (number) of the image sensor **30**; magazine information such as the output pixel density of the image output device **16**, registered print sizes (size information of long and short (longitudinal and lateral) sides), the ID code of a magazine loaded on the image output device **16** and the size (width information) and type of a light-sensitive material accommodated in the magazine; information of an amount of output vignetting allowance in consideration of the skew of the light-sensitive material in the feed unit of the image output device **16** and the main scanning length error caused by a light beam scanning device and the like, an input pixel deficit (a number of pixels) caused by image processing by the LPF (low-pass filter) in the image processing unit **74**, electronic magnification, etc. in the image processing unit **74**, an output image deficit (a number of pixels) caused by image processing by an USM (unsharpness mask), the values of a print image area, print length and the electronic magnification for changing the reading pixel density for image displacement.

Since the image turning control device **82** provided in the control unit **70** is supplied with the information of the light-sensitive material loaded from the image output device **16**, in particular the width information of it, the image turning control device **82** determines whether the recording direction of an image to be output, that is, the main scanning direction of it is the longitudinal direction or the lateral direction of a read image and whether the longitudinal direction and the lateral direction of the read image must be converted or not, that is, whether it is necessary to turn the read image 90° or not. When it is necessary to turn the read image, the image turning control device **82** turns it.

Incidentally, the image output device **16** two-dimensionally exposes an elongated light-sensitive material wound to a roll-shape by scan exposing (printing) the light-sensitive material being fed in a sub-scanning direction with a light beam deflected in a one-dimensional direction which approximately perpendicular to the sub-scanning feed direction, that is, in a main scanning direction. As a result, whether the main scanning is executed in the longitudinal direction of a set print size or the lateral direction thereof is unconditionally determined depending upon the width of the light-sensitive material.

On the other hand, the direction of the strip A set to the film carrier **32** and the direction of the slide B set to the slide carrier **34** are fixed in the image input device **12**. Thus, when it is intended to make the region of the original image read by the image sensor **30** as large as possible, the direction of the film original, that is, the shape of the original image and thus the shape of the carrier mask (for example, an aspect ratio in particular) are unconditionally determined. Accordingly, there is a case that one line of the original image which is read by the image input device **12** is not matched with one line of the image output device **16** in the main scanning direction. As a result, it is necessary that the image turning control device **82** processes the image signal and turns the image (image region) by 90°; That is, it changes the arrangement of the pixels and converts the access order of a frame memory address based on a conversion formula so that the line direction of the output image matches the line direction of the exposure at least before the image signal stored in the frame memory **91** is exposed with light by the image output device **16**.

Further, the control unit **70** is provided with the negative/positive conversion circuit **84** for subjecting the image data having been subjected to the specific signal processing by the signal processing unit **72** to positive/negative conversion. When the strip A and the slide B are a reversal film, the negative/positive conversion circuit **84** converts the image information having been subjected to specific image processing to a negative image and outputs it as the negative image (vice-versa) before the image information is supplied to the image output device **16**. A method of positive to negative and negative to positive conversion is not particularly limited and any known method (image processing method) may be used.

Although whether the strip A and the slide B are a negative film or a reversal film is determined in the present invention from the information stored in the memory **78** based on the carrier ID code which is transferred from the carrier ID code discrimination means **31** when a carrier is mounted, the method of determination is not limited to the above arrangement and the operator may input the type of the strip A and the slide B.

Various types of conventional printers ordinarily execute pre-scanning for roughly reading the original image in order to set image processing conditions and the like prior to the precise reading (main scanning) of the original image for outputting an image. For this purpose, the frame memory **91** of the signal processing unit **72** shown in FIG. **7** includes a pre-scanning frame memory **91***a* and a main scanning frame memory **91***b* arranged as a toggle memory as shown in FIG. **8**. The image processing unit **74** used in the present invention applies necessary image processing to the image signal of the film original stored in the frame memories **91***a*, **91***b*, for example, to the image signal of the three primary colors R, G, B of a single image.

As shown in FIG. **8**, the image processing unit **74** includes a display image processing circuit **92** for subjecting the pre-scanned image signal stored in the pre-scanning frame memory **91***a*, for example, a G color image signal to image processing for displaying it on the monitor **18**; a recording image processing circuit **94** for cutting out the image signal of the pixels of the cut-out pixel region (the number of pixels) which is determined by the method of the present invention from the main-scanned image signal stored in the main scanning frame memory **91***b* to supply the image signal to the image output device **16**, subjecting the thus cut-out image signal to proper image processing for print, subjecting it to LPF (low-pass filter) processing for dodging, subjecting the cut-out pixel region (the number of pixels) to enlargement/reduction processing according to the electronic magnification determined by the method of the present invention, and executing USM (unsharpness mask) processing for making an image acute thereby to provide an output image signal; and a CPU **98** for constituting image processing, condition setting device **96** for setting the image processing conditions of the main-scanned image signal in the recording image processing circuit **94** from the pre-scanned image signal, a main subject set if necessary and desired processing conditions input by the operator.

Although the image is read by the image input device **12** and processed by the controller **14** in the illustrated example, the present invention may execute processing similar to the above processing by reading an image signal stored in a memory medium such as a server, a hard disc, a magnetic-optical disc, a floppy disc and the like as the external memory device **20**, in addition to the above arrangement. On the contrary, the image signal stored in the frame memory **91** may be stored in the external memory device **20** so that it is used later.

The controller 14 of the present invention is essentially arranged as described above.

Next, the image output device 16 receives an image signal from the controller 14, deflects light beams for exposing red (R), green (G) and blue (B) which were modulated by the image signal in a light beam scanning device, for example, a laser scanner in the main scanning direction as well as draws out an elongated light-sensitive material wound to a roll shape from a magazine by the feed unit and feeds it in the sub-scanning direction perpendicular to the main scanning direction to thereby two-dimensionally scan expose the light-sensitive material, subjects the thus exposed light-sensitive material P to color development processing in a development device and further to bleaching/fixing processing and wash processing, dries the light-sensitive material in a drier and cuts it to respective frames by a discharge device and outputs the light-sensitive material as prints.

The digital print apparatus 10 shown in FIG. 1 can set a plurality of sizes to a film original serving as a subject to be processed and a print to be output, that is, the apparatus 10 can set the plurality of sizes of the film original and the plurality of sizes of the print to the memory 78 of the controller 14 shown in FIG. 7 through the CPU 76, and the sizes of the film original can be arbitrarily combined with the sizes of the print.

For example, even the standard print size of the 135 film includes three types of sizes, namely, the L size (89 ×127 mm), H size (89×158 mm) and panorama size (89×250 mm) in correspondence to the sizes of images recorded on the film such as the full size (F), high-vision size (H) and panorama size (P). Further, even the standard print size of the 240 film includes the C (classic) size, H (hi-vision size) and P (panorama) size likewise depending upon the difference in recorded image sizes. Although there are of course many other print sizes in addition to the above print sizes, it is needless to say that the digital print apparatus 10 of the illustrated example for embodying the present invention can cope with these many print sizes.

In an ordinary digital print, each film original has a dedicated carrier depending upon its size and its type (refer to the film carrier 32 in FIG. 2 and the slide carrier 34 in FIG. 3) and the carrier can be mounted on and dismounted from the carrier base 26 of the image input device 12 shown in FIG. 2. When a carrier, for example, the film carrier 32 is mounted on the carrier base 26 as shown in FIG. 2, the carrier ID code of the film carrier 32 is transmitted to the CPU 76 and recognized by it. At the same time, the magazine ID code of a magazine loaded on the feed unit of the image output device 16 is transmitted from the image output device 16 to the CPU 76 and recognized by it. Although the memory 78 of the controller 14 stores the mask size information of the film original, the width information of the light-sensitive material and the like, these types of the information cannot be rewritten by the user.

Although a plurality of print sizes to be output are set to the memory 78 when the apparatus is shipped from a factory, these print sizes registered to the memory 78 are display on the screen of the monitor 18 as a print size list and the user selects a desired print size displayed on the screen of the monitor 18 by means of the data input unit such as the keyboard 22*a* and the mouse 22*b*. When the desired print size is not registered, the user can register a new print size or correct a registered print size using the keyboard 22*a* or the like and further can rewrite the content of the memory 78.

As to the optical magnification of the zoom lens in the digital print apparatus 10 of the illustrated example, standard optical magnifications which can be unconditionally determined only by the carrier ID codes are stored in the memory 78 when the apparatus is shipped from the factory.

When a carrier ID code and a magazine ID code are obtained and an output print size is selected in the digital print apparatus 10, a magnification is automatically calculated by the CPU 76 and the optical magnification of the zoom lens and the electronic magnification are automatically set. That is, first, a standard optical magnification which is inherent to the carrier ID code is automatically set as the optical magnification of the zoom lens from the memory 78. Then, when no trimming is executed in the present invention, in particular when the film original is read in an automatic or semi-automatic mode, the optical magnification can be fixed to the standard optical magnification or a set optical magnification after fine adjustment. How the optical magnification and the electronic magnification are calculated will be described later.

In the digital print apparatus 10 of the illustrated example, the image signal captured in prescanning from the entire pixels of the effective pixel region (for example, 1380 pixels×920 pixels) of the image sensor 30 to which an image born by the film original is projected is captured to the frame memory 91 (prescanning frame memory 91*a*) of the signal processing unit 72 of the controller 14 and thinned and then displayed on the monitor 18 (for example, 345 pixels×230 pixels).

In main (fine) scanning, the image signal of the entire pixels of the effective pixel region of the image sensor 30 is captured likewise. However, since the film original has a plurality of sizes and thus the mask also has a plurality of sizes, the image projected from the mask image (original image in the open region of the mask) of all the film originals is not projected to the entire effective pixel region of the image sensor 30 and in general projected inwardly of it. Accordingly, the image signal of the pixels only in the mask image region must be taken out from the image signal of the entire pixels in the effective pixel region to which the image is read as the image signal of the pixels in the input pixel region so that the image signal is used to reproduce a print. Therefore, the present invention sets the size (the number of pixels) of the input pixel region to the size (the number of pixels) of the effective pixel region of the image sensor 30 in such a manner that the image signal of the pixels at the edges of the film original and the mask can be surely removed even if the dislocation of the optical axis, a magnification error, a film original stop position error and the like are taken into consideration and the image signal of the pixels as many as possible in the opening region of the mask can be surely taken out and can be captured to the frame memory 91 (91*b*) as the image signal of the pixels in the input pixel region. Note, the image signal of the entire pixels of the effective pixel region of the image sensor 30 may be captured to the main scanning frame memory 91*b* and only the image signal of the pixels of the input pixel region may be read out.

Likewise, in the optical system of the image input device 12, the standard optical magnification is set so that the image projected from the mask image of the film original can be surely and sufficiently accommodated within the effective pixel region of the image sensor 30. Therefore, the standard optical magnification is an optical magnification which ensures that the mask image of the film original is surely projected to the effective pixel region of the image sensor 30, the edge of the film original never appears on a print or the edge of the mask is never recorded on the print when the print is output in a desired print size, the effective pixel

region of the image sensor **30** is sufficiently used and fine image quality is obtained. When the zoom lens unit **62** is actually set to the standard optical magnification, the CPU **76** reads out, from the magnification-pulse table stored in the memory **78**, a number of pulses from an origin (home position) which is applied to the magnification adjustment motor **63** to obtain an amount of movement from the origin which is necessary to move the zoom lens group **66** of the zoom lens unit **62** to a position where the set optical magnification is realized and the magnification adjustment motor **63** is driven by the number of pulses to thereby move the zoom lens group **66** and stop it at the position where the standard optical magnification is realized.

Next, the CPU **76** calculates the electronic magnification (for example, 120%) for creating the image signal of the pixels of the output pixel region (for example, 1531 pixels×1082 pixels) which is necessary to output a print having a desired print size (for example, 127 mm×89 mm) at a specific output pixel density (for example, 300 dpi) from the image signal of the pixels of the input pixel region (for example, 1340 pixels×920 pixels) using various set values which were set when the apparatus was shipped from the factory and in consideration of, for example, an amount of output image vignetting allowance such as the skew and recording length error of the light-sensitive material of the image output device **16** and the pixel deficit (vignetting) in the image processing unit **74** in accordance with the output print size, reads the image signal of the pixels to the signal processing unit **72** in consideration of the vignetting, determines the pixel region (for example, 1292 pixels×918 pixels) which will be cut out from the effective pixel region of the image sensor **30** and captured to the frame memory **91** (**91***a*, and **91***b* if necessary) and displays a finished print region (for example, 323 pixels×229 pixels) as the reference line on the monitor **18** (for example, 345 pixels×230 pixels).

In the digital print apparatus **10** of the illustrated example, the image in the finished print region within the reference line displayed on the monitor **18** is output from the image output device **16** as it is.

When, however, it is desired to change the region of the original image which is reproduced on a print, that is, when it is desired to reproduce a part of the original image on the print or when it is desired to adjust an amount of vignetting of the original image in the image reproduced on a print, a trimming job can be executed. The trimming job can be executed by various methods in the present invention. The trimming method can be divided into, for example, a method of using the film carrier **32** and the slide carrier **34** from the point where the film original is positioned and a method of using the trimming carrier **160**. There are also a method of giving precedence to the optical magnification achieved by the zooming operation of the zoom lens unit **62** from the view point of a print magnification, a method of giving precedence to the electronic magnification achieved by image processing, a method of using both the methods, and the like. When it is desired to adjust the amount of vignetting of the original image, although it is preferable that the user adjusts the optical magnification from the standard or set optical magnification by zooming operation by using the film carrier **32** and the **34** while observing the original image displayed on the monitor **18**, the user may also use the trimming carrier **160**.

When only a part of the original image is trimmed, it is also possible to move the reference line (cursor) showing a finished print region on the monitor **18** through the keyboard **22***a* and the mouse **22***b* and enlarge or reduce the electronic magnification by changing it and match the finished print region with a trimming region using the film carrier **32** and the slide carrier **34** while remaining the standard or set optical magnification as it is or after the optical magnification is adjusted by the zooming operation while the image region which is trimmed and printed is within the effective pixel region of the image sensor **30** or preferably until the trimming region inscribes or nearly inscribes the effective pixel region.

When the trimming carrier **160** is used, the trimming job can be executed using the electronic magnification or both the optical magnification and the electronic magnification. In this case, however, since the position of the film original can be freely adjusted, the center of the trimming region of the image of the film original can be caused to match with the center of the effective pixel region of the image sensor **30**. Accordingly, it is preferable to cause the trimming region of the original image to match with the reference line in the image displayed on the monitor **18** by changing the optical magnification so that the trimming region is increased as large as possible until it inscribes the effective pixel region of the image sensor **30**.

Although the present invention essentially executes trimming by switching the method of giving preference to the optical magnification and the method of giving preference to the electronic magnification, it is preferable to give preference to the optical magnification as far as possible and switch the optical magnification to the electronic magnification only when the optical magnification approaches its limit, in order to obtain a print whose image quality is less deteriorated without a blurred feeling. In particular, when a print has a low magnification and the optical magnification is possible, it is preferable to execute trimming by changing only the optical magnification while fixing the electronic magnification or setting it to a possible minimum value, whereas in the region where the optical magnification is impossible, it is preferable to achieve a desired print magnification by fixing the optical magnification to its possible limit value and switching it to the electronic magnification.

Even if the above method is employed, when a print has a high magnification, the electric magnification is increased and image quality is deteriorated. To deal with this problem, it is preferable to prevent or reduce the deterioration of the image quality by changing the reading pixel density by displacing pixels in accordance with the electronic magnification.

The trimming job executed by the optical magnification can be carried out in such a manner that the user directly indicates an optical magnification, the user indicates the print magnification and the CPU **76** calculates and sets the optical magnification, or the user indicates the start and stop of zooming which is executed by the magnification adjustment motor **63**. In these cases, it is preferable that an actually set magnification is displayed on the monitor **18**. After the above factors are indicated, the use confirms the image in a specific trimming region by the image of the image sensor **30** in the print and a finished print region, namely, a reference line showing the trimming region which are displayed on the monitor **18**. When a desired trimmed image is not obtained, the user can repeat the trimming job for adjusting the optical magnification until the desired trimmed image is obtained. It is needless to say that the user may indicate the stop of the magnification adjustment motor **63** when the desired trimmed image region is matched with the region within the reference line by the continuous zooming of the zoom lens unit **62** executed by the magnification adjustment motor **63** while observing the enlargement and reduction of the original image displayed on the monitor **18**.

In the present invention, since the reference line displayed on the monitor **18** sufficiently takes image vignetting (pixels) caused by the image processing executed until the original image read by the image sensor **30** is reproduced on the print into consideration, the reproduced image actually printed on the print is not almost displaced. Thus, it is sufficient to confirm the trimmed image on the monitor **18**. It is needless to say that the trimming job may be executed while actually outputting the print.

Incidentally, when the desired trimmed image is obtained and reproduced on the print and the trimming job is finished, the optical magnification which has been set by being subjected to the specific adjustment to obtain the original image reproducing region of the print returns to the standard optical magnification which is inherently preset to the digital print apparatus. As a result, when it is desired to adjust original image reproducing regions on a print to all the original images recorded to a type of a film original, for example, a reversal film, although it is possible to adjust the reproducing regions by executing the trimming job to each of the original images, it is very trouble some to execute the trimming job to all of the original images.

To deal with this problem, the digital print apparatus of the illustrated example permits the original image reproducing region on a print to be set to a specific region at all times in accordance with the preference of the user. This is realized in the present invention by setting an amount of adjustment, that is, a magnification fine adjustment value to the preset standard optical magnification. That is, the magnification fine adjustment value is made variable to the standard optical magnification between a maximum value and a minimum value which are inherent to the image input device **12**. Thus, the optical magnification can be set to a specific set optical magnification by setting the magnification fine adjustment value to a specific value between the maximum value and the minimum value. Note, when the optical magnification is set to the standard optical magnification, the magnification fine adjustment value is set to 100%, whereas when it is desired to fix the optical magnification to the standard optical magnification, it suffices only to fix the magnification fine adjustment value to 100%.

Although the digital print apparatus of the present invention is essentially arranged as described above, a digital print method of the present invention will be described below in detail with reference to FIG. **9**, FIG. **10** and FIG. **11**. FIG. **9** is a block diagram showing an example of a basic process for embodying the digital print method of the present invention, FIG. **10** is a flowchart showing an embodiment of an optical magnification setting method in the method of the present invention and FIG. **11** is a flowchart showing an embodiment of an electronic magnification calculation method and a method of cutting-out a cut-out pixel region.

First, in the digital print apparatus **10** shown in FIG. **1**, the CPU **76** of the controller **14** shown in FIG. **7** obtains the carrier ID code of a carrier mounted on the carrier base **26** of the image input device **12** shown in FIG. **2** therefrom and the magazine ID code of a magazine mounted on the feed unit of the image output device **16** shown in FIG. **1** therefrom, reads the mask size information of a film original and the width information of a light-sensitive material, and the like from the memory **78** of the controller **14** and displays them on the monitor **18**.

The operator selects a desired print size registered in the memory **78** on the screen of the monitor **18** using the keyboard **22*a*** and the mouse **22*b*** and if the desired print size is not registered, the operator adds or corrects the desired one and executes necessary operation for setting other conditions and the like, whereby initialization executed by the CPU **76** is finished as shown in FIG. **10** and FIG. **11**.

First, how the optical magnification is set will be described with reference to FIG. **9** and FIG. **10**. As shown in FIG. **10**, it is assumed that the carrier holding a film original for which the original image reproducing region on the print is desired to be set to the specific region is mounted on the image input device **12** and the CPU **76** reads and recognizes the carrier ID code of the carrier as the reading means thereof and reads and selects a standard optical magnification corresponding to the carrier ID code as a reading optical magnification T1 from the memory **78**.

When the user selects a magnification adjustment mode from a menu, a list of carriers and print sizes is displayed on the monitor **18**. The user selects a combination of a target carrier (the carrier ID code of which is recognized) and a target print size through the data input device **22** and inputs an amount of adjustment, namely, a magnification fine adjustment value T2 to the combination. Although the magnification fine adjustment value T2 is set (stored) to 100% as a default value when the apparatus was shipped from the factory, the user can inputs a numeral in the range of 50% to 150% as the default value. When the numeral of the magnification fine adjustment value T2 is input by the user, the value of the magnification fine adjustment value T2 stored in the memory **78** in correspondence to the combination of the carrier ID code and the print size is updated.

Next, the CPU **76** calculates an actual optical magnification T3 which is actually set according to the following formula from the reading optical magnification T1 as the calculation of an adjustment optical magnification for adjusting the optical magnification of the zoom lens unit **62** and the magnification fine adjustment value T2.

$$T3 = T1 \times T2/100$$

Next, the CPU **76** refers to the magnification-pulse table in the memory **78** as means for calculating an amount of movement of the zoom lens group **66** and converts the actual optical magnification T3 calculated by the above formula into a scanner control value P1 which is represented by the number of pulses to be applied to the magnification adjustment motor **63** for moving the zoom lens group **66** from the origin (home position). Since the magnification-pulse table is set as a design value, it is similarly arranged to any apparatuses. However, since the apparatuses are inevitably arranged differently due to a part error, an assembly error, an adjustment error and the like, a magnification calibration correcting pulse P2 which is inherent to each of the apparatuses to compensate the difference of the arrangement of the respective apparatuses in the actual optical magnification T3 is read from the memory **78** and an actual scanner control value P3 which is represented by the number of pulses actually applied to the magnification adjustment motor **63** is determined from the following formula. Note, the magnification calibration correcting pulse P2 is an adjustment parameter for compensating the difference in arrangement of the respective apparatuses when they are shipped from the factory.

$$P3 = P1 + P2$$

The zoom lens group **66** is moved by driving the magnification adjustment motor **63** by the thus obtained actual scanner control value P3 to thereby set the optical magnification of the zoom lens unit **62** to the actual optical magnification T3. Thereafter, the display screen of the

monitor **18** returns to a print screen, the image of the film original is read by the image sensor **30** in the input device **12** and a prescanned image is displayed on the monitor **18**. When a trimming job is not executed, since the optical magnification and thus the magnification fine adjustment value is set to 100% or a fixed value, the setting of the optical magnification is finished.

When, however, the trimming job is executed, the user compares the original image display region thus displayed on the monitor **18** with a reference line showing a finished print region or actually outputs a main scanned and read image from the image output device **16** as a print, visually confirms how the original image reproducing region is adjusted on the print, and if necessary, repeats the trimming job until a desired original image reproducing region is obtained on a desired print.

In the present invention, since the reference line displayed on the monitor **18** sufficiently takes the image vignetting, caused until the original image read by the image sensor **30** is reproduced on the print, into consideration, the range of the image in the finished print region shown by the reference line is not displaced from the range of the reproduced image actually printed. Thus, it is needless to say that the adjusted state may be confirmed on the monitor **18** or the actually output print may be confirmed by actually outputting the print.

Note, the magnification fine adjustment value T2 may be determined by calculation in such a manner that an original provided with a measurable scale is used as the film original, the original with the scale is displayed on the monitor **18** or actually printed out and the displayed or the output scale is measured.

As described above, the magnification fine adjustment value T2 of the inherent standard optical magnification T1 can be set as the default value of the digital print apparatus **10** in correspondence to the combination of a type of a carrier (a size of a film original) and a print size to obtain an original image reproducing area desired by the user regardless of that trimming is executed or not. Thus, when the same combination is selected, since a particular magnification fine adjustment value T2 stored in the memory **78** is read out, the same original image reproducing region desired by the user can be obtained on a print. When it is desired to return the standard optical magnification to its initial state at the time the apparatus was shipped from the factory, the value stored in the memory **78** can be easily returned to its original state by setting the magnification fine adjustment value T2 to 100% again.

The method of adjusting the set optical magnification according to the present invention is essentially arranged as described above.

Next, how the electronic magnification is calculated and how the cut-out pixel region is cut out according to a method of the present invention will be described. As shown in FIG. **11**, when the print size is set as described above, the CPU **76** determines whether the image must be turned by 90° by the image turning device **82** or not from the width information of the light-sensitive material and the longitudinal side and the lateral side of the print is determined. When, for example, a light-sensitive material has a width of 127 mm and the print size is an L size (long side (H) 127 mm×short side (V) 89 mm), the image need not be turned when it is output because main scanning is effected along the long side and sub-scanning is effected along the short side. However, when the print size is a 2L size (long side (H) 178 mm×short side (V) 127 mm), since the main scanning is effected along the short side and the sub-scanning is effected along the long side when the image is output, the image must be turned.

This will be described below with reference to a case that the print size is the L size as a typical example. That is,

print size	long side; HO0 = 127 mm short side; VO0 = 89 mm

Next, in the determination of the cut-out pixels in the present invention, when an output pixel region is calculated, output sizes HO1, VO1 are determined by adding, to the print size, amounts of output vignetting allowance Ox, Oy, for example, 2.5 mm for both of them which were preset as a design parameter inherent to the image output device **16** and read out by the CPU **76** directly from the image output device **16** or through the memory **78**. As shown in FIG. **7**, the amounts of output vignetting allowance for an output image are values added due to the skew of the light-sensitive material in the image output device **16**, a main scanning length error and the like.

output size long side; HO1=HO0+Ox or Oy=129.5 mm
short side; VO0=VO0+Oy or Ox=91.5 mm

Next, the output pixel region (the number of pixels) will be determined by dividing the output sizes by an output pixel density RO, for example, 300 dpi (=0.08467 mm) which is read from the image output device **16** directly or indirectly through the memory **78** likewise the above (in the example, all digits to the right of the decimal point are rounded up to make the quotient to an integer).

output pixel region long side;

$$HO2 = HO1 \div RO = 1530 \text{ pixels}$$

short side;

$$VO2 = VO1 \div RO = 1081 \text{ pixels}$$

In the determination of an input pixel region, calculation will be executed so that the mask opening region determined from a preset mask size inscribes or nearly inscribes the preset effective pixel region (for example, 1380 pixels (main)×920 pixels (sub) and when pixels are increased by a factor of four by a pixel displacement mechanism, 2760 pixels (main×1840 pixels (sub)) of the image sensor **30** (hereinafter, referred to as a CCD) to thereby determine the input pixel region (the number of pixels) captured to the main scanning frame memory **91***b* of the signal processing unit **72**.

When the aspect ratio (main/sub ratio) of the effective pixel region of the CCD is larger than the aspect ratio (main/sub ratio) of the mask opening region:

input pixel region long side;

$$HI0 = \text{CCD effective pixel region (main)} \times \text{mask opening region aspect ratio} = 1340 \text{ pixels}$$

short side;

$$VI0 = \text{CCD effective pixel region (sub)} = 920 \text{ pixels}$$

Whereas, when the aspect ratio (main/sub ratio) of the effective pixel region of the CCD is smaller than the aspect ratio (main/sub ratio) of the mask opening region:

input pixel region long side;

$HI0$ = CCD effective pixel region (main)

short side;

$VI0$ = CCD effective pixel region (sub) ÷ mask opening region aspect ratio

Next, in the determination of the cut-out pixel region, the input pixel region is corrected by subtracting an input pixel deficit **Ek0** (for example, 5 pixels in total) which is vignetted by various types of image processing such as the low-pass filter (LPF) processing applied to an input image signal by the recording image processing circuit **93** of the image processing unit **74**, enlargement/reduction processing and the like from the thus determined input pixel region.

corrected input pixel region long side;

$$HI1 = HI0 - Ek0$$
$$= 1335 \text{ pixels}$$

short side;

$$VI1 = VI0 - Ek0$$
$$= 915 \text{ pixels}$$

On the other hand, the output pixel region is corrected by adding an output pixel deficit **Ek1** (for example, 14 pixels) which is vignetted (removed) from the previously determined output pixel region by image processing such as unsharpness mask (USM) processing to the image signal and the like.

corrected output pixel region long side;

$$HI2 = HO2 + Ek1$$
$$= 1544 \text{ pixels}$$

short side;

$$VI2 = VO2 + Ek1$$
$$= 1095 \text{ pixels}$$

The electronic magnification is determined by dividing the thus determined corrected output pixel region by the corrected input pixel region as to each of the long side and the short side. In the example, the quotients are rounded up at the third digit to the right of the decimal point thereof in consideration of adjustment accuracy and the larger one of the values for the long side and the short side is employed as the electronic magnification.

electronic magnification

$$Me = MeV$$
$$= 1.20\ (= 120\%)$$

long side;

$$MeH = HI2 \div HI1$$
$$= 1.16\ (= 116\%)$$

short side;

$$MeV = VI2 \div VI1$$
$$= 1.20\ (= 120\%)$$

The pixel region (the number of pixels) to be cut out from the input pixel region stored in the frame memory **91*b*** is calculated using the electronic magnification Me so that it is made to the corrected output pixel region (rounding-up is also effected here to provide an integer).

cut-out pixel region long side;

$$HFB = HI2 \div Me + Ek0$$
$$= 1292 \text{ pixels}$$

short side;

$$VFB = VI2 \div Me + Ek0$$
$$= 918 \text{ pixels}$$

Next, in the re-correction of the output pixel region, the output pixel region to be supplied to the image output device **16** is determined using the thus obtained cut-out pixel region (rounding-up is also effected here to provide an integer).

output pixel region long side;

$$HO3 = (HFB - Ek0) \times Me - Ek1$$
$$= 1531 \text{ pixels}$$

short side;

$$VO3 = (VFB - Ek0) \times Me - Ek1$$
$$= 1082 \text{ pixels}$$

The input pixel region (the number of pixels) which is cut out from the frame memory **91*b*** in which the image born by the film original and read by the image sensor **30** is stored as the image signal and the output pixel region (the number of pixels) which is supplied to the image output device **16** are determined as described above.

As shown in FIG. **9**, the monitor **18** instantly displays the image of the film original read by the image sensor **30** in the prescanning as it is. However, the number of pixels (the pixel density) which can be displayed on the monitor **18** is limited, smaller than the number of pixels read by the image sensor **30** and lower than the reading pixel density. In the example, the number of reading pixels of the image sensor **30** is 1380 pixels×920 pixels, whereas the number of display pixels of the monitor **18** is, for example, 345 pixels×230 pixels, thus the latter is one fourth the former. As a result, the stop position of the film original can be confirmed in real time, that is, it can be confirmed in real time whether the film original correctly stops at the reading position Z of the carrier. Further, as shown in FIG. **9**, the monitor **18** displays the aforesaid cut-out pixel region as the reference line showing the finished print region. Thus, the image of a finished print can be confirmed and even if trimming which will be described later is executed, a trimming state can be simply and correctly confirmed.

In the print bearing image reproduced using the image signal of the pixels of the thus obtained output pixel region, the vignetted amount of the film original bearing image which is removed from the image surface of the film original until the image is reproduced to the image surface of the print is minimized except the inevitably vignetted amount which is previously taken into consideration as shown in the essential process of FIG. **9**. That is, the vignetting of the image such as the amount of output vignetting allowance in the image output device **16**, the pixel deficit in the image processing unit **74** and the like is previously taken into consideration and the amount of vignetting allowance of the image projected to the image sensor (CCD) **30** such as the displacement of the optical axis of the zoom lens unit **62**, the optical magnification error and the like is minimized as well

as previously taken into consideration. For example, the mask whose opening region inscribes or nearly inscribes the image surface of the film original is used and the reading optical magnification of the zoom lens unit **62** is adjusted and set such that the projected image inscribes or nearly inscribes the effective pixel region of the CCD. As a result, there is no difference between the image region of the finished print displayed on the monitor **18** and the image region of the print output from the image output device **16** and the print bearing image is reproduced from the film original bearing image as much as possible.

Next, when the film original bearing image is trimmed by the optical zooming using the zoom lens unit **62**, since the image projected from the trimmed original image can be set to such a size that it inscribes or nearly inscribes the effective pixel region of the image sensor **30**, the trimming can be executed entirely likewise the method described above. Therefore, the relationship between the trimming range and the main (fine) scanned image is entirely the same as the aforesaid relationship because a zoomed image is displayed on the monitor **18** as a prescanned image of 345 pixels×230 pixels.

Further, when the trimming is executed by electronic zooming in which the operator indicates a trimming range by the reference line from the film original image displayed on the monitor **18**, the long side HD and the short side VD of the pixel region (the number of pixels) in the indicated trimming range are determined and the number of pixels on the frame memory **91*b*** is calculated and set as the input pixel region (the number of pixels).

input pixel region long side;

$$HI0 = HD \times MX + Ha$$

short side;

$$VI0 = VD \times MX + Va$$

MX represents the ratio between a reading (CCD) pixel density and a display pixel density, Ha, Va represent the fine adjustment values of the amounts of allowance to the vignetting of the long side and short side and are set in consideration of the vignetting due to the image processing unit **74** and the image output device **16**. The method of calculation executed thereafter is the same as that executed when no trimming is effected.

Therefore, the reference line displayed on the monitor **18** correctly shows the trimming region as the finished print image region. Since the reference line showing the trimming region is of course displayed in consideration of the pixel deficit caused by the processing executed thereafter, a conceivable error factor is only an amount of displacement of the light beam scanning unit of the image output device **16** from a design value. Since the amount of displacement is compensated in a reference scanning length, it is needless to say that there is no dislocation between the trimming region and the image region of the print output from the image output device **16**. Therefore, the trimming job can be simply executed with a pinpoint accuracy by the method of the present invention.

The CPU **76** automatically sets the size of a film original to be read and a mask size by reading a standard optical magnification corresponding to a carrier ID code stored in the memory **78** using a previously obtained carrier ID code. When the size of a film original to be read is the same, although it is preferable that the standard optical magnification of the image input device **12** is set to the same value regardless of a set print size, the arrangement is not limited thereto.

When the reading optical magnification is read out as described above, the CPU **76** sets the reading optical magnification by adjusting the zoom lens unit **62**. At the time, the size of the image of the film original projected to the image sensor **30** is set to such condition that it inscribes or nearly inscribes the effective pixel region of the image sensor **30**. Further, the cut-out pixel region of the image sensor **30** is selected to satisfy the above condition as well as the size of the projected image is selected to ensure the image of the cut-out pixel region. It is preferable to use the image sensor **30** the aspect ratio of the size of the effective pixel region of which is the same as or near to the aspect ratio of the size of the image surface of the film original or the mask size. Further, as described above, when a light-sensitive material is subjected to digital exposure with a laser beam, the aspect ratio of the print size is considered and an image sensor cut-out condition is selected to the image sensor cut-out pixel region so as to achieve an inscribing or nearly inscribing condition to thereby obtain the recording image region of the film original as large as possible as well as ensure fine image quality by using the effective pixels of the image sensor **30** as much as possible.

Although the digital print method and apparatus of the present invention have been described above in detail, the present invention is by no means limited to the above embodiments and it goes without saying that various improvements and modifications can be made in the range which does not depart from the gist of the present invention.

As described above in detail, according to the present invention, when no trimming is executed, the optical magnification is fixed and the electronic magnification is changed each time a print size changes in a film original having the same film size even if recorded images have a different size. Further, the fixed optical magnification is the standard or set optical magnification which permits the image of the film original to be projected to the effective image region of the image sensor in the state that it inscribes or nearly inscribes the effective pixel region in a greatest possible degree. As a result, a print on which a reproduced image of high quality is printed can be obtained without the deterioration of image quality in high productivity without the need of effecting the troublesome optical magnification by operating the zoom lens.

Further, according to the present invention, when trimming is executed, since preference is given to the optical magnification over the electronic magnification so long as the optical magnification is possible and the electronic magnification can be executed at the time the optical magnification becomes impossible, even if only a part of the image recorded on a film original is enlarged, the deterioration of image quality can be prevented or minimized. In addition, since a trimming region can be adjusted while confirming it through the monitor, a trimming job can be easily executed as well as a trimming accuracy can be increased. Even if trimming is executed to minimize the vignetting of all the images recorded on the film original, trimmed images of high quality can be easily obtained with a pinpoint accuracy by the confirmation of the trimming through the monitor likewise.

What is claimed is:

1. A method of projecting images in a digital photoprinter, comprising the steps of:

displaying, on a monitor, both a reference line and an image from an original film which is received from an effective pixel region of an image sensor by adjusting at least one of an optical magnification and an electronic magnification, wherein the optical magnification

projects a desired size of the original film image into the effective pixel region of the image sensor, wherein the electronic magnification is determined from an output pixel region based on a desired print size for reproduction of the original film image, and an input pixel region determined from the effective pixel region of the image sensor, and wherein the reference line indicates a cut-out pixel region based on both the output pixel region and the electronic magnification in consideration of an image deficit caused by image processing, the cut-out region created from the effective pixel region and signifying a finishing region of a print having the desired print size;

setting, when no trimming is executed, a desired print magnification by pre-setting the optical magnification in accordance with the film size of the original film, while adjusting the electronic magnification in accordance with the size of the original film image; and

setting, when trimming is executed, the desired print magnification by giving preference to either the optical magnification or electronic magnification, wherein preference is given to the optical magnification when the desired image size for printing is to be matched on the monitor with a trimming region within the reference line, wherein preference is given to the electronic magnification when the trimming region is matched with the desired image size for printing on the monitor, and wherein the preferred optical or electronic magnification is adjusted by visually observing both the desired image and the trimming region within the reference line displayed on the monitor, the display signifying a finishing region of a print having the desired print size.

2. A method according to claim 1, wherein the print magnification is changed by adjusting a reading pixel density of the original film image in accordance with an area or a length of the reproduced image of the print, or according to the electronic magnification set at the time of the trimming.

3. A method according to claim 1 or claim 2, wherein when the trimming is executed, the print magnification is adjusted by giving preference to the optical magnification in a low print magnification in which the optical magnification can be changed by operation of a zoom lens, whereas the print magnification is adjusted by fixing the optical magnification and changing the electronic magnification in ranges where the optical magnification cannot be improved by operation of the zoom lens.

4. A method according to claim 1 or claim 2, wherein when the trimming is executed, the print magnification is adjusted by either the optical magnification or the electronic magnification, depending upon whether the electronic magnification has been set.

5. A method of projecting images in a digital photoprinter, comprising:

displaying, on a monitor, both a reference line and an image from an original film which is received from an effective pixel region of an image sensor by adjusting at least one of an optical magnification and an electronic magnification;

setting, when no trimming is required, a desired print magnification by pre-setting the optical magnification in accordance with the film size of the original film, while adjusting the electronic magnification in accordance with the size of the original film image; and

setting, when trimming is required, a desired print magnification by giving preference to the optical magnification when a desired image size for printing is to be matched on the monitor with trimming region within the reference line, and by giving preference to the electronic magnification when the trimming region is to be matched on the monitor with the desired image size for printing,

wherein the respective preferred optical or electronic magnification is adjusted by visually observing both the desired image and the trimming region within the reference line on the monitor, with the display signifying a finishing region of a print having the desired print size.

6. The method according to claim 5, wherein the print magnification is changed by adjusting a reading pixel density of the original film image in accordance with an area or length of a reproduced image of the print, or in accordance with the electronic magnification set at the time of the trimming.

7. The method according to claims 5 or 6, wherein when trimming is executed, the print magnification is adjusted by giving preference to the optical magnification in a low print magnification in which the optical magnification is adjusted by operation of a zoom lens.

8. The method according to claim 7, wherein, in ranges where the optical magnification cannot be improved by operation of the zoom lens, the print magnification is changed by fixing the optical magnification and adjusting the electronic magnification.

9. The method according to claims 5 or 6, wherein when trimming is executed, whether the print magnification is adjusted by optical or electronic magnification depends upon whether the electronic magnification has been set at the time of trimming.

10. The method according to claims 1 or 5, wherein the original film image is at least one of a plurality of original film images having a plurality of film sizes.

11. The method according to claim 5, wherein the optical magnification projects a desired size of the original film image into the effective pixel region of the image sensor.

12. The method according to claim 5, wherein the electronic magnification is determined from an output pixel region based on a desired print size for reproduction of the original print image, and from an input pixel region determined from the effective pixel region of the image sensor, in consideration of an image deficit caused by digital image processing.

13. The method according to claim 5, wherein the reference line indicates a cut-out pixel region based on both an output pixel region and the electronic magnification in consideration the image deficit, the cut-out region created from the effective pixel region and signifying a finishing region of a print having the desired print size.

14. The method according to claim 10, further comprising the steps of:

photoelectrically reading said plurality of images with the image sensor;

subjecting the read images to digital image processing, thereby converting the plurality of images into digital image signals;

exposing a light-sensitive material based on the digital image signals; and

subjecting the light-sensitive material to development processing so as to obtain reproduced images having a plurality of print sizes.

* * * * *

US006314198B1

(12) United States Patent
Ogura

(10) **Patent No.: US 6,314,198 B1**
(45) **Date of Patent: Nov. 6, 2001**

(54) **RADIOGRAPHIC, DIGITAL IMAGE PROCESSING SYSTEM**

(75) Inventor: **Takashi Ogura**, Tokyo (JP)

(73) Assignee: **Canon Kabushiki Kaisha**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/223,598**

(22) Filed: **Dec. 30, 1998**

(30) **Foreign Application Priority Data**

Sep. 25, 1996	(JP)	10-271576
Jan. 8, 1998	(JP)	10-002272
Mar. 25, 1998	(JP)	10-077348
Oct. 30, 1998	(JP)	10-311330
Dec. 16, 1998	(JP)	10-357628

(51) **Int. Cl.**[7] **G06K 9/00**

(52) **U.S. Cl.** **382/132**

(58) **Field of Search** 382/128, 131, 382/132, 168, 170, 171, 172, 173, 174, 190, 192, 194, 274, 275, 276, 282, 291, 305, 307, 309, 312, 316, 318; 250/580, 581, 582, 584, 200, 559.01, 559.02, 559.04, 1.05, 1.07, 1.08, 1.19, 1.29, 206, 206.1, 206.2, 472.1, 473.1, 475.2, 492.1, 493.1, 494.1, 505.1; 378/4, 9, 11, 12, 16, 19, 20, 21, 22, 54, 58, 62, 63, 162, 165

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,084,911	1/1992	Sezan et al.	378/96
5,319,693 *	6/1994	Eberhard et al.	378/19
5,483,604 *	1/1996	Salisbury	382/152
5,526,442 *	6/1996	Baba et al.	382/132
5,668,845 *	9/1997	Migita	378/4
5,740,267 *	4/1998	Echerer et al.	382/132
5,883,985 *	3/1999	Pourjavid	382/274

FOREIGN PATENT DOCUMENTS

0 857 983 A2	8/1998	(EP)	G01T/1/29

* cited by examiner

Primary Examiner—Andrew W. Johns
Assistant Examiner—Shervin Nakhjavan
(74) *Attorney, Agent, or Firm*—Morgan & Finnegan, LLP

(57) **ABSTRACT**

A radiographic, digital image processing system is adapted to process a radiographic, digital image, the radiographic, digital image processing system including a photosensor area defining device for defining an image area corresponding to a location of a photosensor for detecting intensity during radiography on a radiographic, digital image obtained by the radiography, and a characteristic amount generating device for generating a characteristic amount in the image area corresponding to the location of the photosensor on the radiographic, digital image defined by the photosensor area defining device, whereby the characteristic amount corresponding to the location of the photosensor on the radiographic, digital image can be generated without troubling an operator.

142 Claims, 17 Drawing Sheets

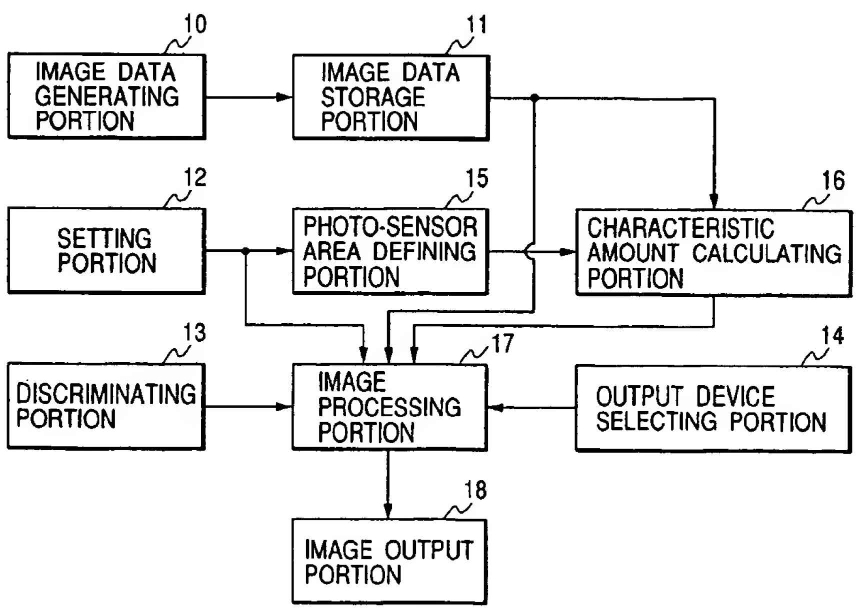


FIG. 1

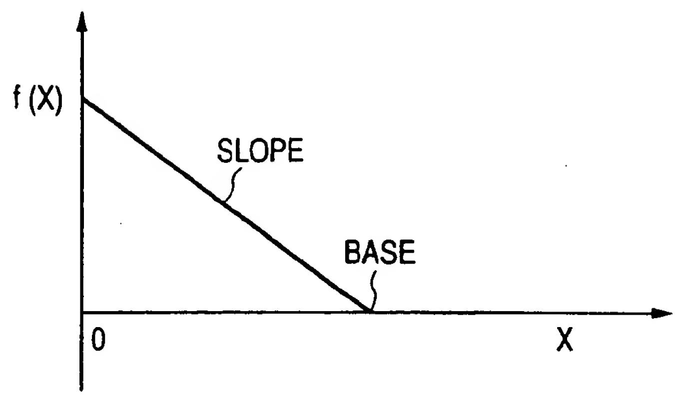

f (X)
SLOPE
BASE
0
X

FIG. 2

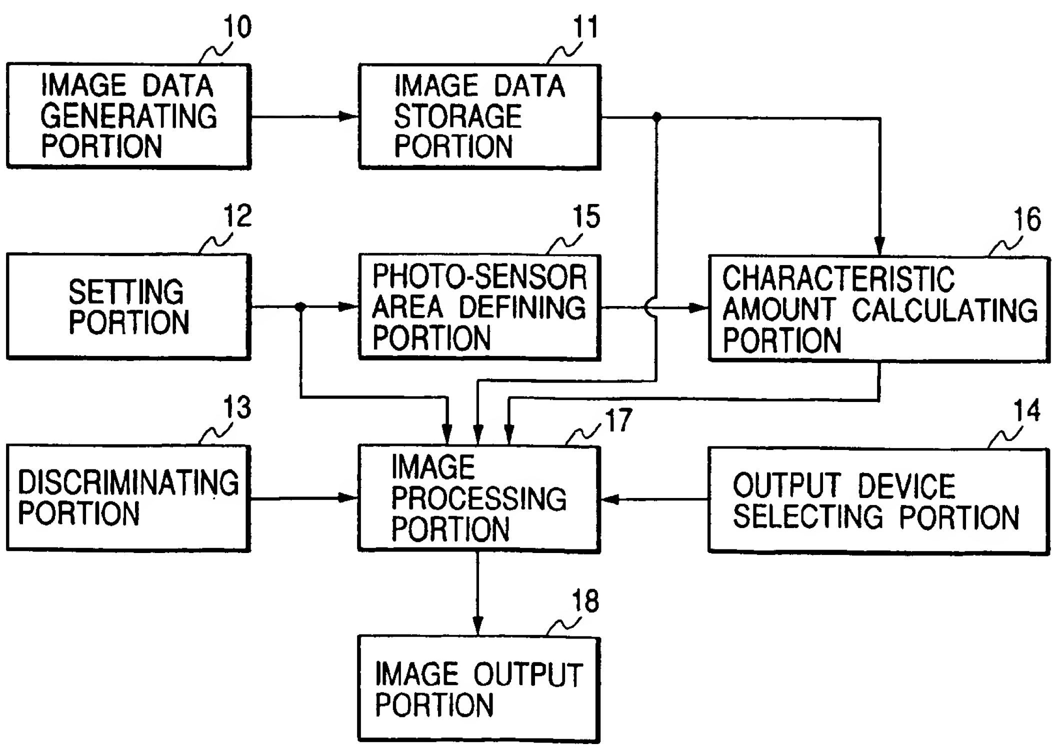

10
IMAGE DATA GENERATING PORTION
11
IMAGE DATA STORAGE PORTION
12
SETTING PORTION
15
PHOTO-SENSOR AREA DEFINING PORTION
16
CHARACTERISTIC AMOUNT CALCULATING PORTION
13
DISCRIMINATING PORTION
17
IMAGE PROCESSING PORTION
14
OUTPUT DEVICE SELECTING PORTION
18
IMAGE OUTPUT PORTION

FIG. 3

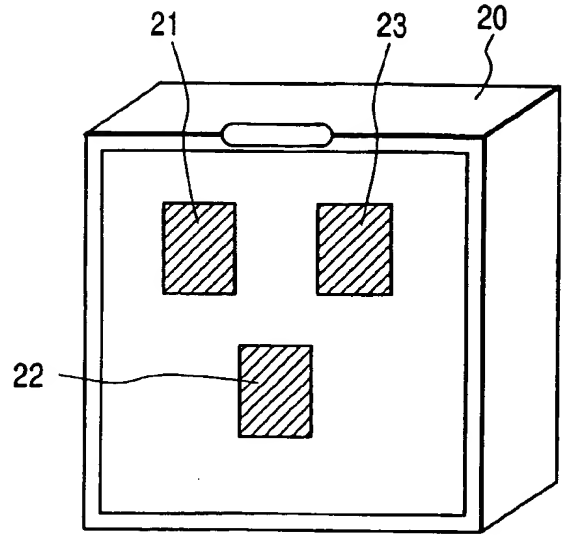


FIG. 4

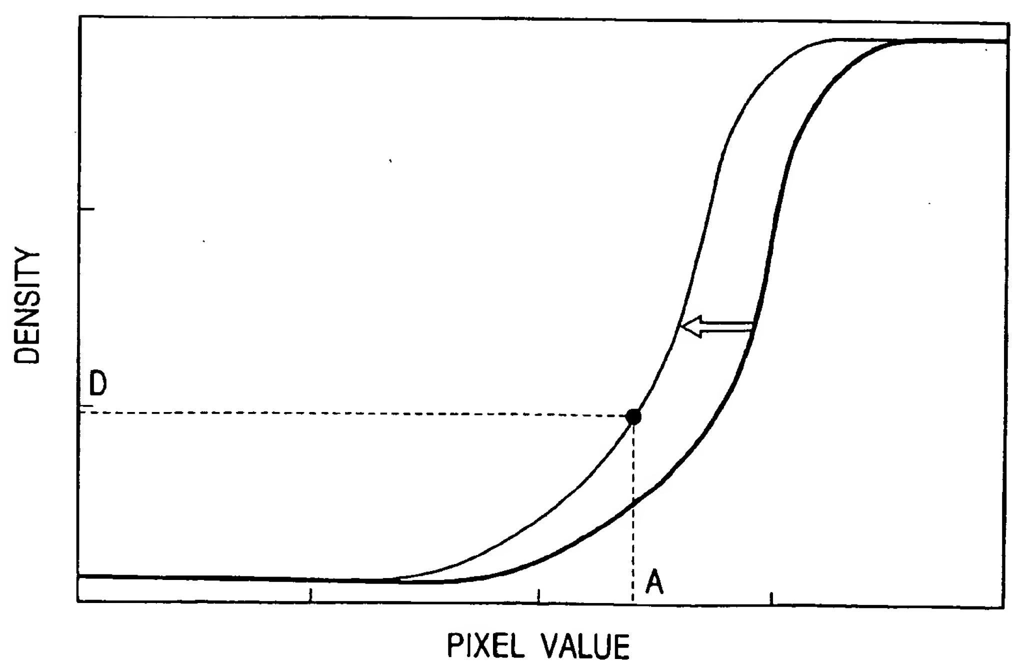


FIG. 5

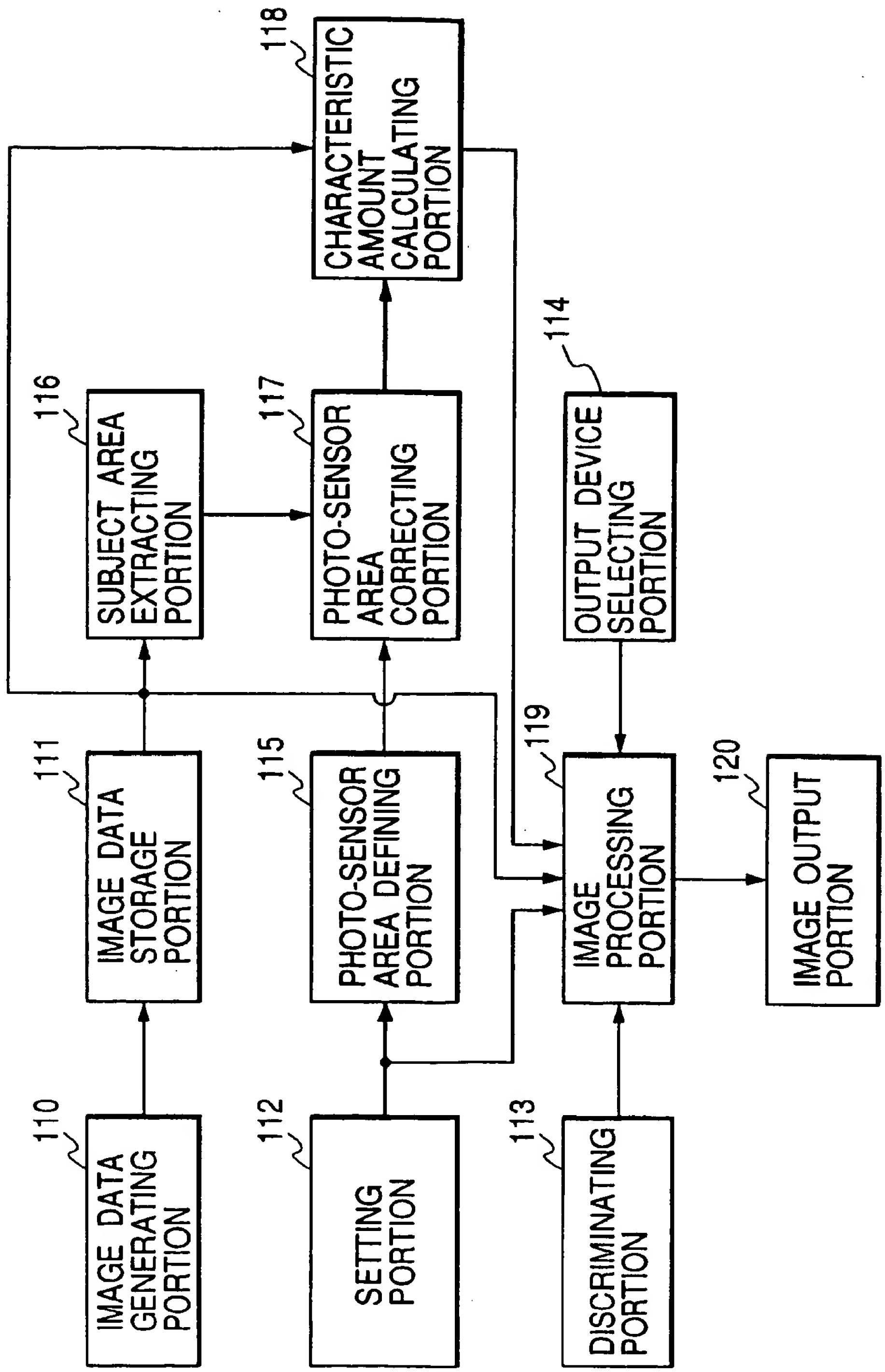

110
IMAGE DATA GENERATING PORTION
111
IMAGE DATA STORAGE PORTION
112
SETTING PORTION
113
DISCRIMINATING PORTION
114
OUTPUT DEVICE SELECTING PORTION
115
PHOTO-SENSOR AREA DEFINING PORTION
116
SUBJECT AREA EXTRACTING PORTION
117
PHOTO-SENSOR AREA CORRECTING PORTION
118
CHARACTERISTIC AMOUNT CALCULATING PORTION
119
IMAGE PROCESSING PORTION
120
IMAGE OUTPUT PORTION

FIG. 6

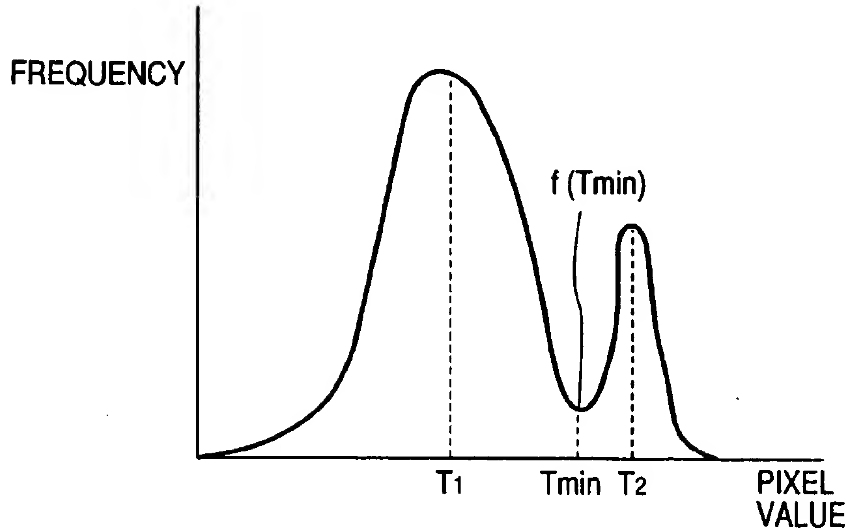


FIG. 7

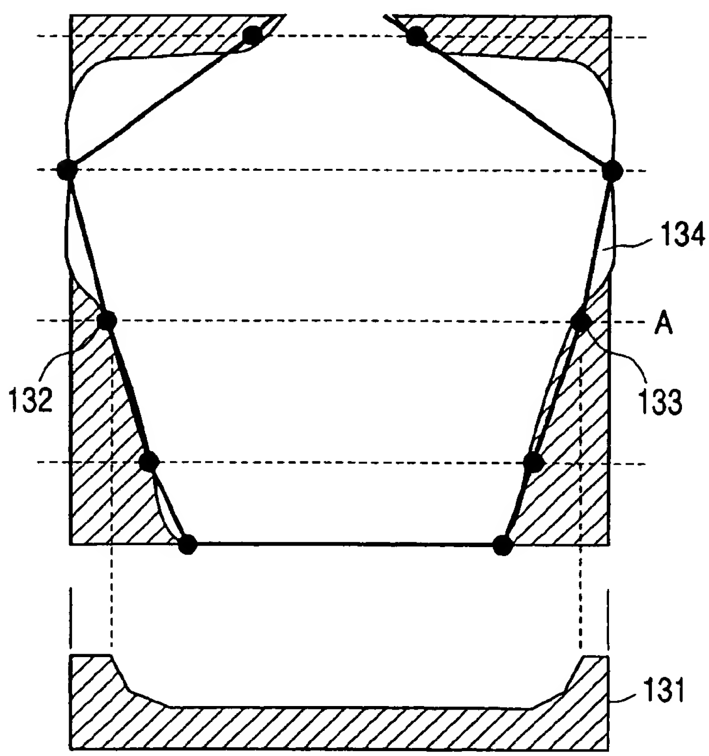


FIG. 8

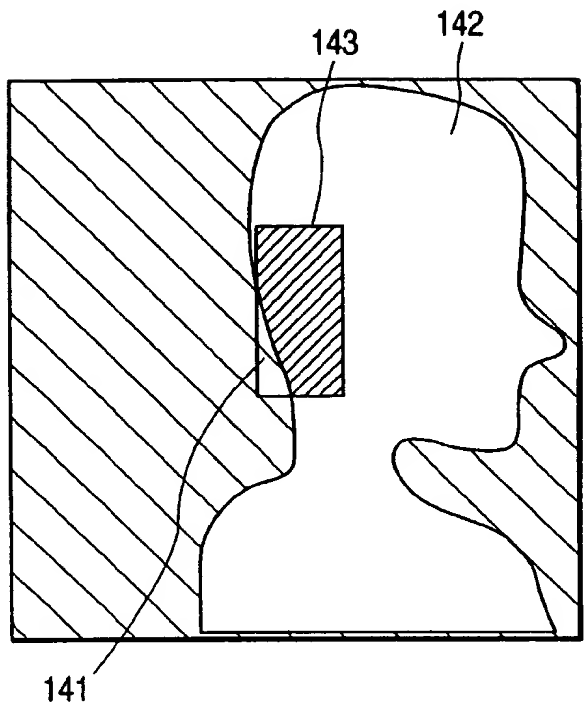


FIG. 9

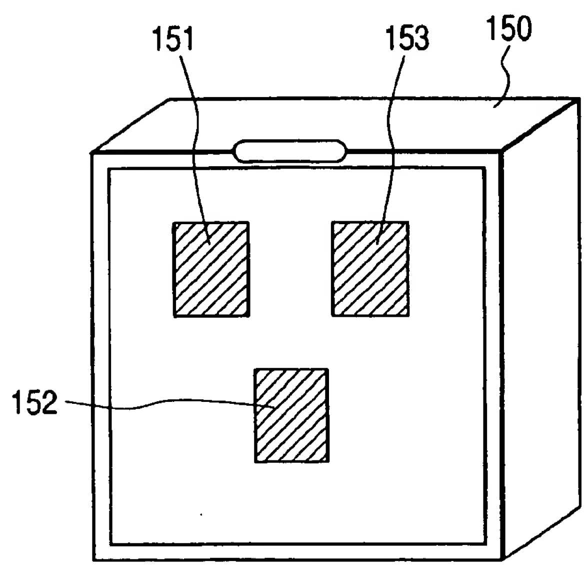


FIG. 10

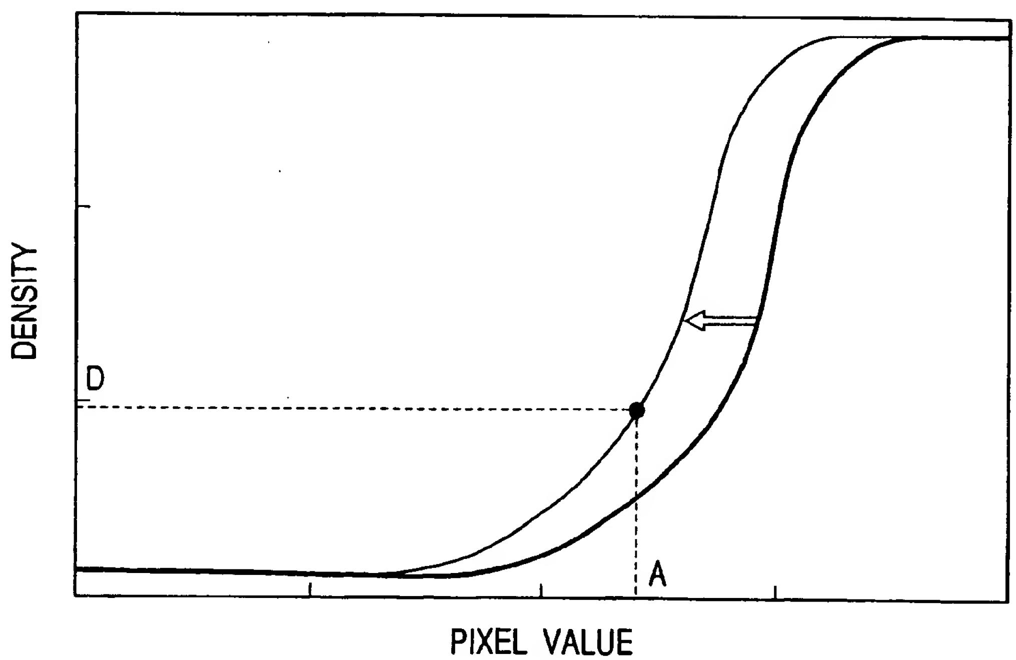


FIG. 11

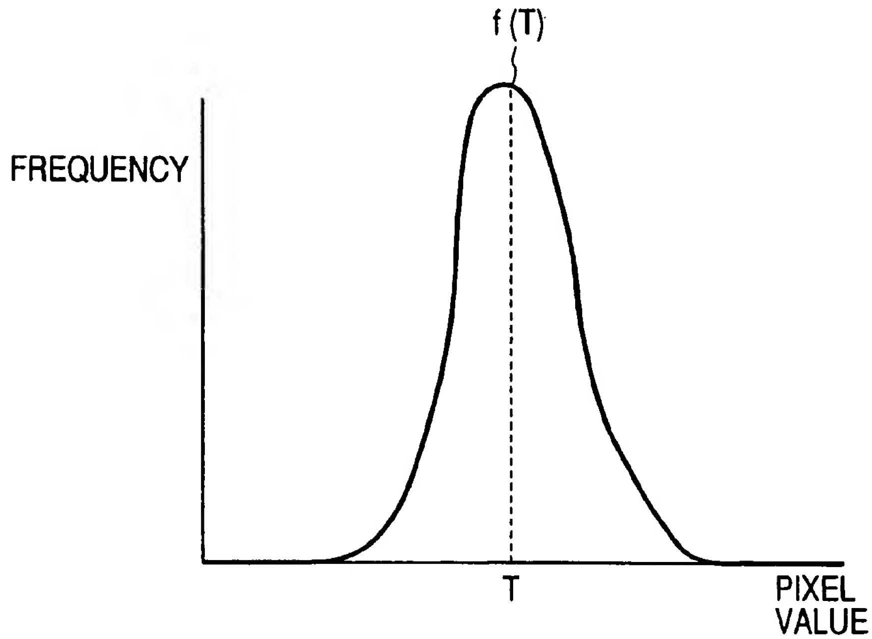

f (T)
FREQUENCY
T
PIXEL VALUE

FIG. 12

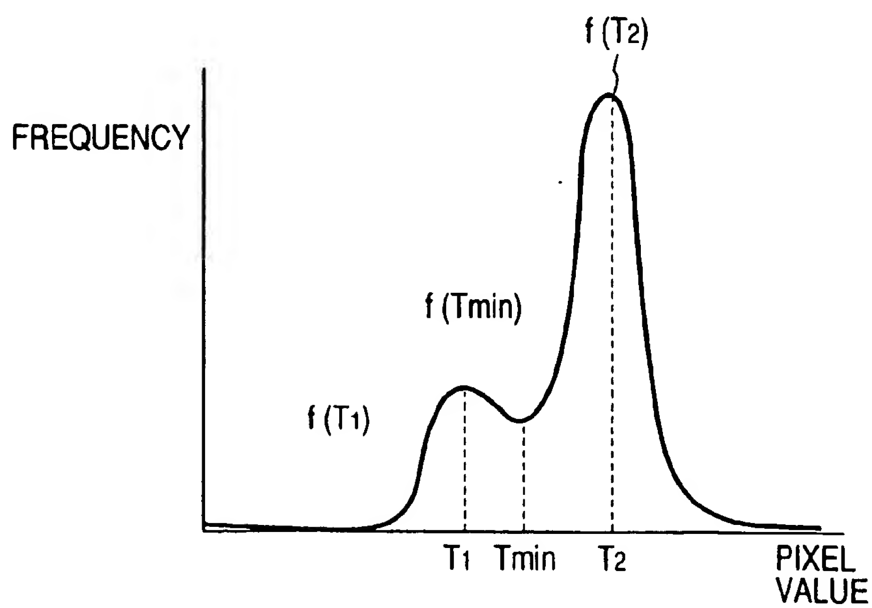

f (T2)
FREQUENCY
f (Tmin)
f (T1)
T1
Tmin
T2
PIXEL VALUE

FIG. 13

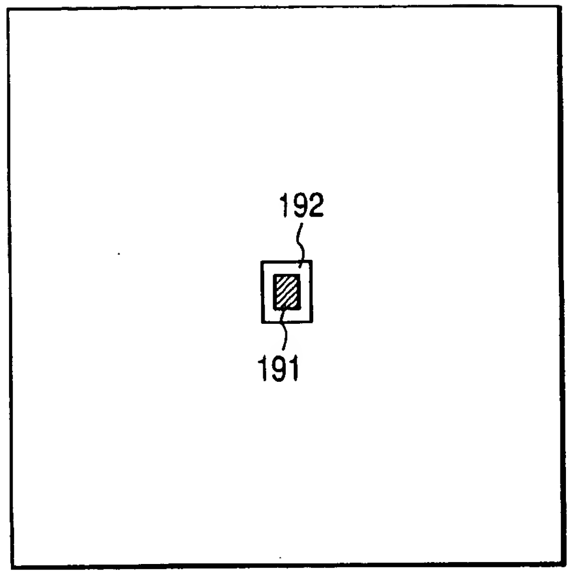


FIG. 14

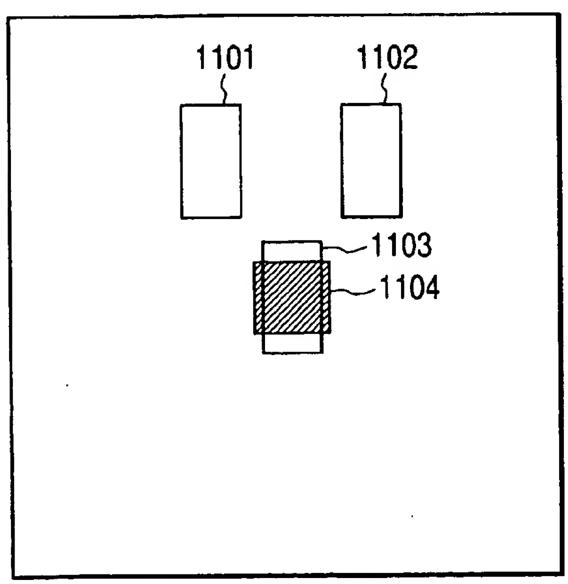
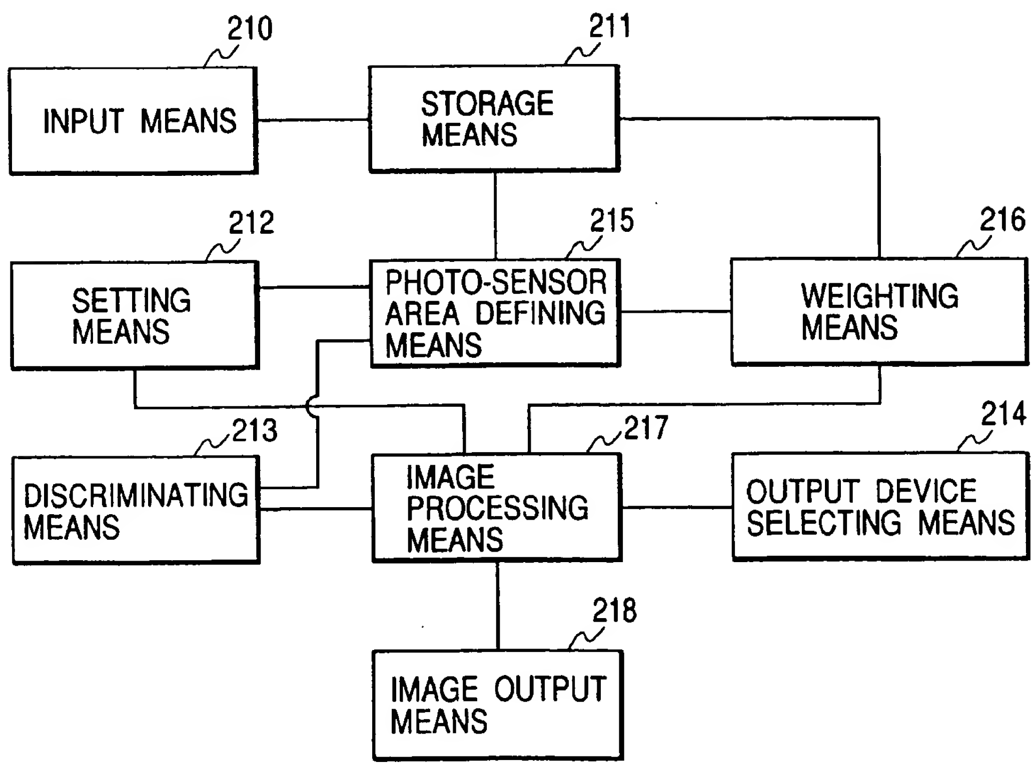


FIG. 15



210
INPUT MEANS
211
STORAGE MEANS
212
SETTING MEANS
215
PHOTO-SENSOR AREA DEFINING MEANS
216
WEIGHTING MEANS
213
DISCRIMINATING MEANS
217
IMAGE PROCESSING MEANS
214
OUTPUT DEVICE SELECTING MEANS
218
IMAGE OUTPUT MEANS

FIG. 16

1	2	3	4	5	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	5	4	3	2	1

FIG. 17

1	1	1	1	1	1	1	1	1
1	2	2	2	2	2	2	2	1
1	2	3	3	3	3	3	2	1
1	2	3	4	4	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	4	4	3	2	1
1	2	3	3	3	3	3	2	1
1	2	2	2	2	2	2	2	1
1	1	1	1	1	1	1	1	1

FIG. 18

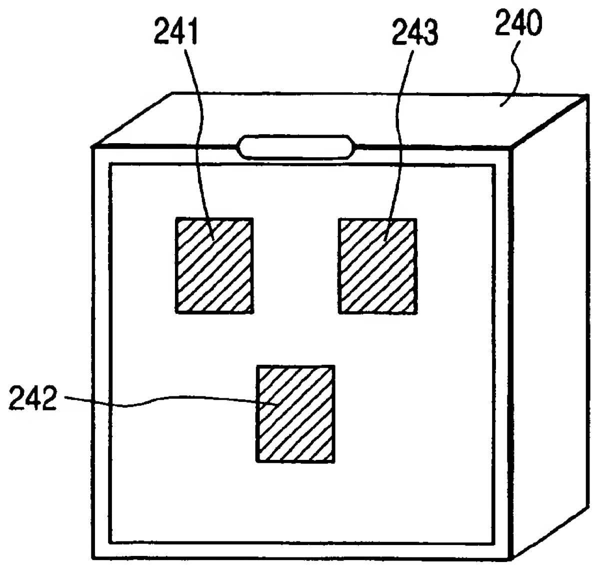


FIG. 19

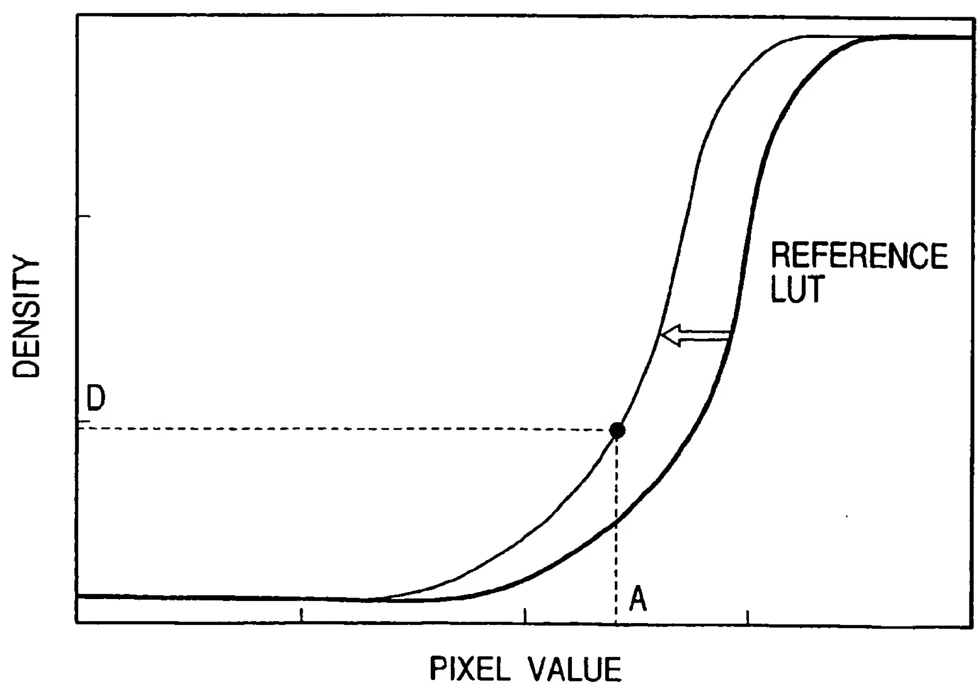


FIG. 20

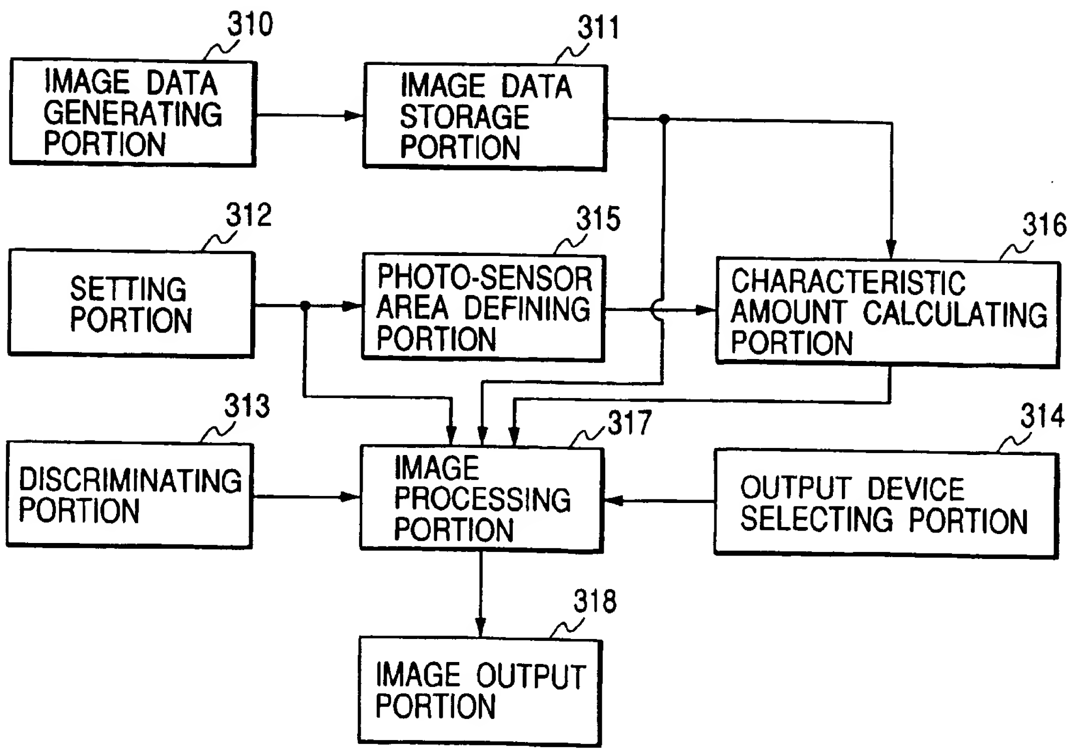

310
IMAGE DATA GENERATING PORTION
311
IMAGE DATA STORAGE PORTION
312
SETTING PORTION
315
PHOTO-SENSOR AREA DEFINING PORTION
316
CHARACTERISTIC AMOUNT CALCULATING PORTION
313
DISCRIMINATING PORTION
317
IMAGE PROCESSING PORTION
314
OUTPUT DEVICE SELECTING PORTION
318
IMAGE OUTPUT PORTION

FIG. 21

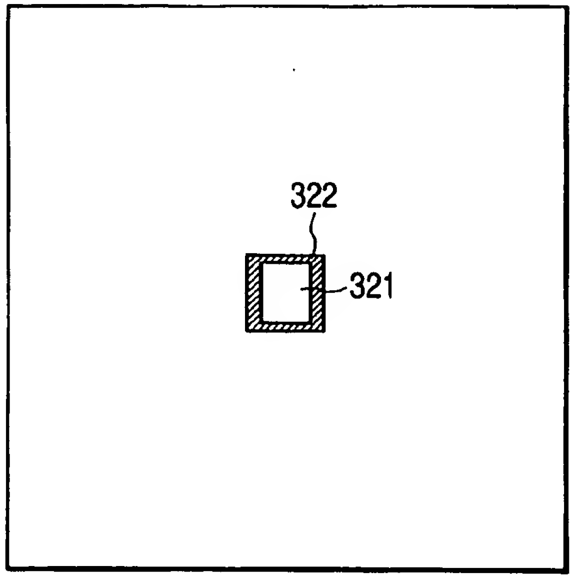


FIG. 22

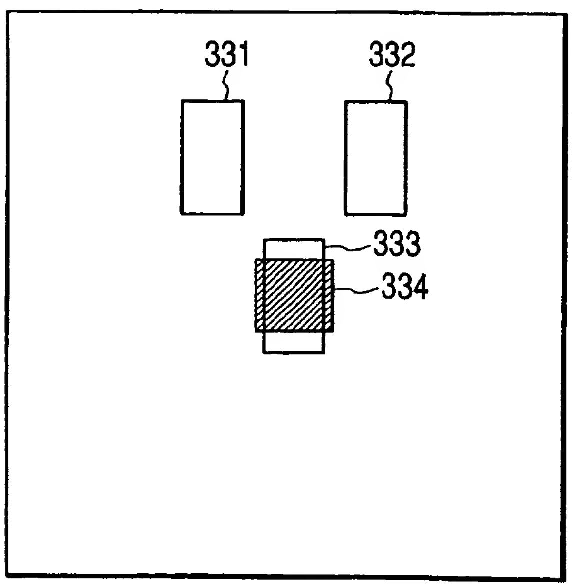


FIG. 23

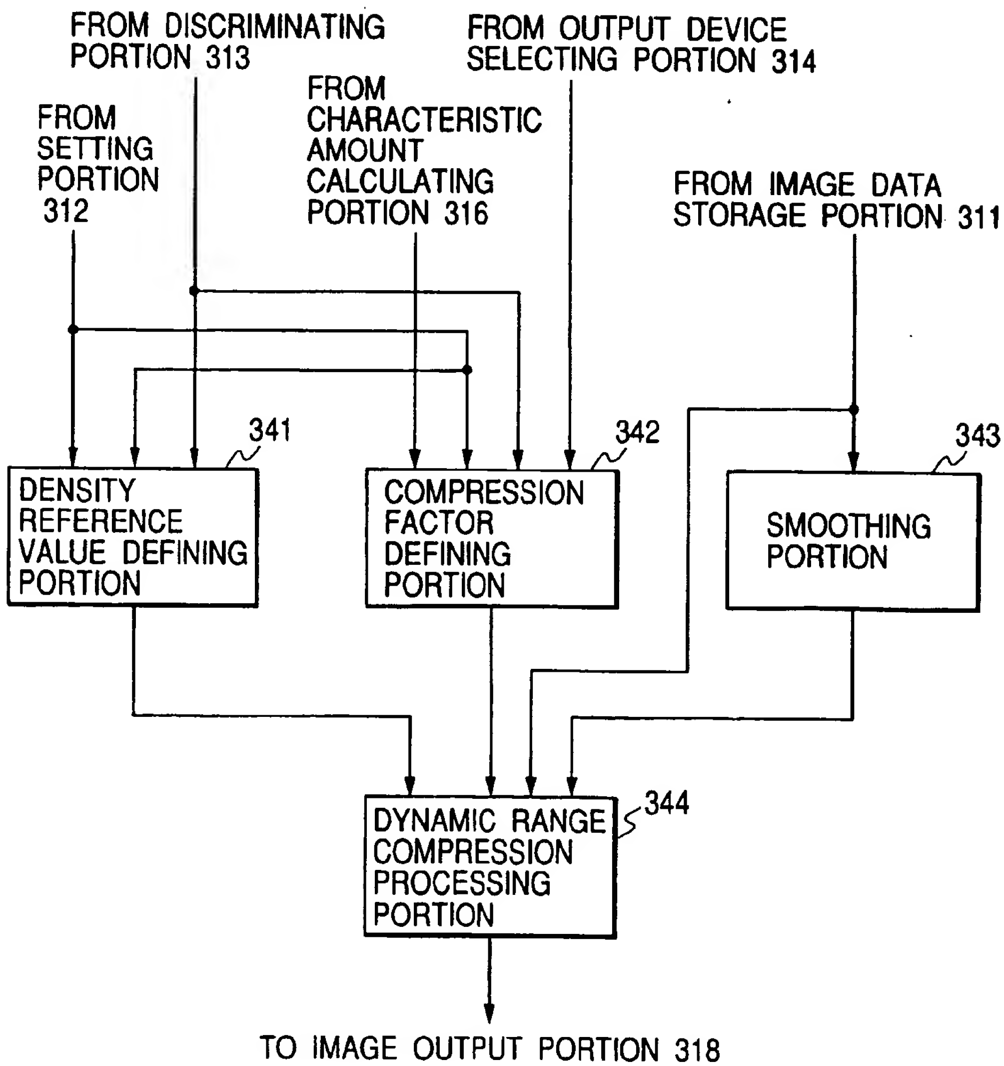

FROM DISCRIMINATING PORTION 313
FROM OUTPUT DEVICE SELECTING PORTION 314
FROM SETTING PORTION 312
FROM CHARACTERISTIC AMOUNT CALCULATING PORTION 316
FROM IMAGE DATA STORAGE PORTION 311
341
342
343
DENSITY REFERENCE VALUE DEFINING PORTION
COMPRESSION FACTOR DEFINING PORTION
SMOOTHING PORTION
344
DYNAMIC RANGE COMPRESSION PROCESSING PORTION
TO IMAGE OUTPUT PORTION 318

FIG. 24

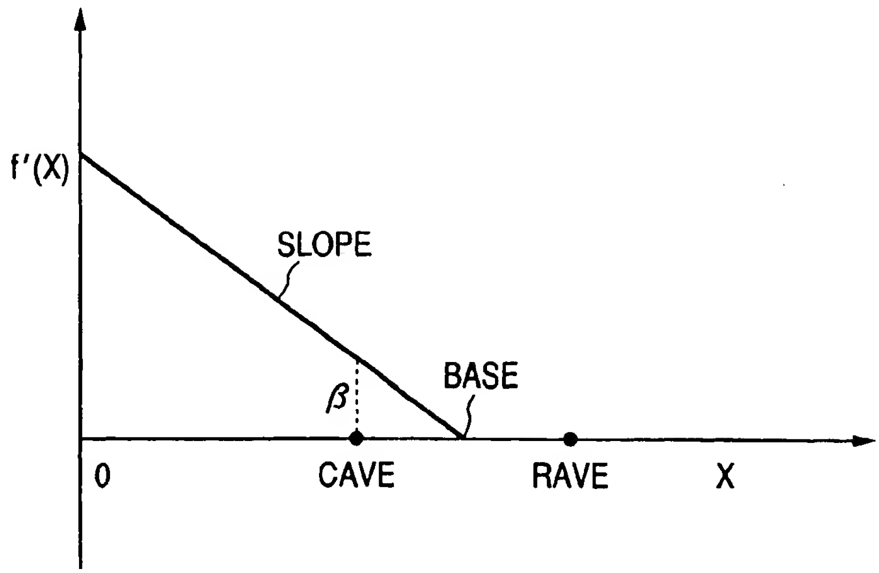


FIG. 25

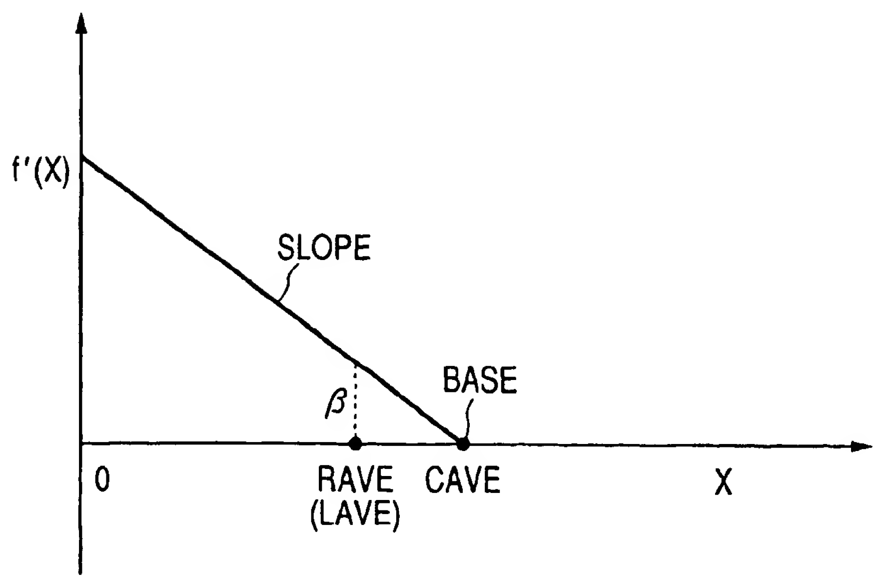


FIG. 26

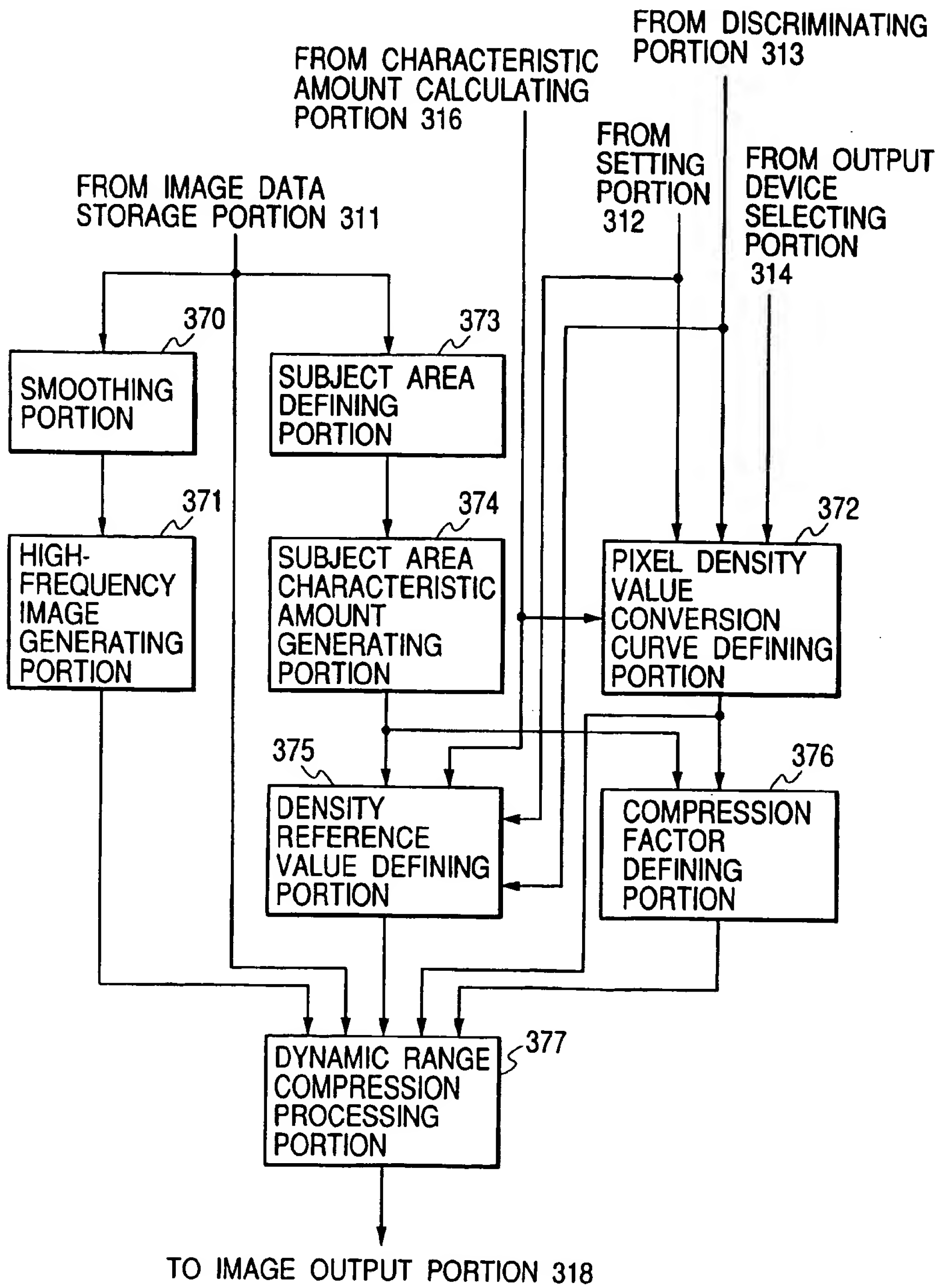

FROM DISCRIMINATING PORTION 313
FROM CHARACTERISTIC AMOUNT CALCULATING PORTION 316
FROM SETTING PORTION 312
FROM OUTPUT DEVICE SELECTING PORTION 314
FROM IMAGE DATA STORAGE PORTION 311
370
SMOOTHING PORTION
373
SUBJECT AREA DEFINING PORTION
371
HIGH-FREQUENCY IMAGE GENERATING PORTION
374
SUBJECT AREA CHARACTERISTIC AMOUNT GENERATING PORTION
372
PIXEL DENSITY VALUE CONVERSION CURVE DEFINING PORTION
375
DENSITY REFERENCE VALUE DEFINING PORTION
376
COMPRESSION FACTOR DEFINING PORTION
377
DYNAMIC RANGE COMPRESSION PROCESSING PORTION
TO IMAGE OUTPUT PORTION 318

FIG. 27

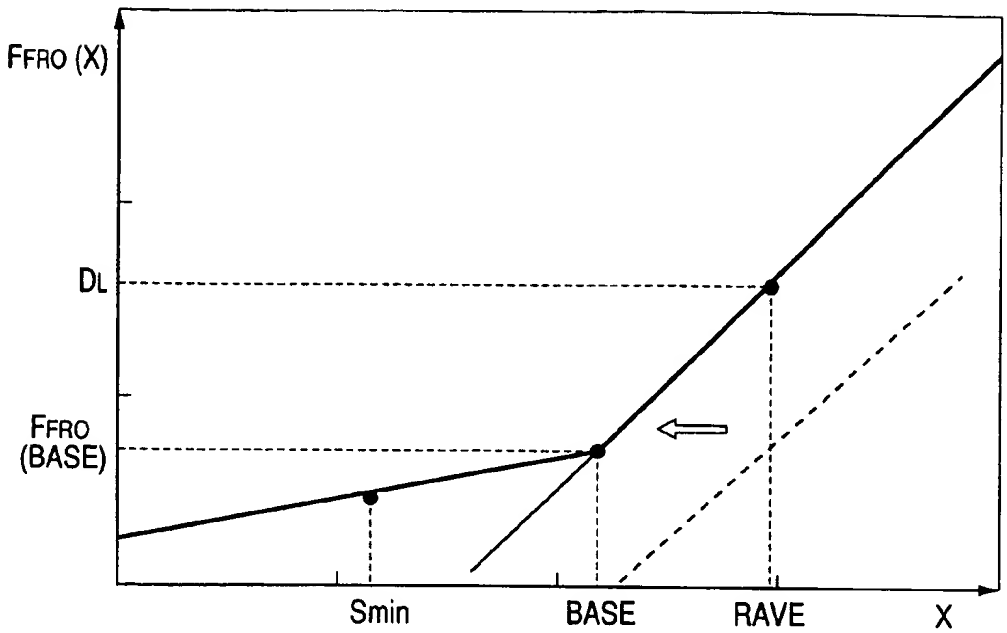
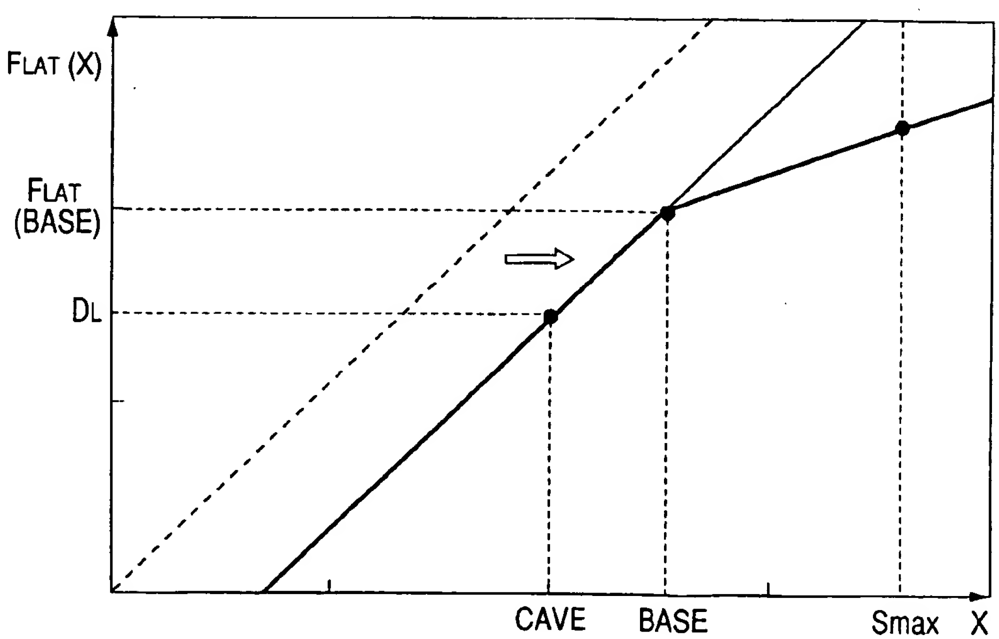

FFRO (X)
DL
FFRO (BASE)
Smin
BASE
RAVE
X

FIG. 28


FLAT (X)
FLAT (BASE)
DL
CAVE
BASE
Smax
X

RADIOGRAPHIC, DIGITAL IMAGE PROCESSING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates a radiographic, digital image processing system for processing a radiographic, digital image.

2. Related Background Art

In recent years, development has been made in radiographic image taking systems arranged in such structure that radiations such as X-rays are radiated onto a subject, a radiographic image as a transmitted image of the subject is picked up directly by a solid state image sensing device, and an image signal corresponding to the radiographic image thus picked up is displayed as a visible image on a CRT (Cathode Ray Tube) display device or the like; or, the image signal corresponding to the radiographic image thus picked up is digitized, image processing is carried out in the digital data state, and it is printed out.

In the radiographic image taking systems described above, photographing portions differ depending upon their photographic purposes, and in the image processing step for visualizing the radiographic image the optimum density and gradation vary every image of processed portion. Therefore, it is necessary to carry out different image processing operations among images of the respective portions.

Meanwhile, computer networks are also spreading recently in medical treatment facilities. Under such circumstances, in addition to the radiographic image taking systems described above, there are also cases where a single image processing device is used to process pieces of radiographic image information taken by different radiographic image taking devices such as a radiographic image taking device using a photo-stimulable phosphor sheet (CR) and a radiographic image taking device using an image intensifier (DR) or the like and the radiographic image information thus processed is outputted to either one of different output devices such as the CRT display device, a film imager device, and a dry printer device.

In the above-stated cases, the operator himself manipulating the image processing device had to carry out a setting operation including a plurality of procedures in order to match the image processing carried out in the image processing device with each taking device or with each output device. This operation was very troublesome to the operator.

When the chest part is photographed, an area of interest varies depending upon circumstances; for example, the area of interest is the pulmonary field in some cases or is a bone part in other cases. Depending upon whether the actual area of interest is the pulmonary field or the bone part, the operator himself had to manipulate an input device such as a mouse or a touch panel so as to carry out the image processing operation in the density and gradation, different between the areas, and to set the image processing device so as to carry out the image processing operation adapted for the area of interest in the radiographic image. These operations also took some time of the operator.

When the subject was a patient provided with a radiation-absorbing auxiliary device such as a pacemaker or a fitting for fixing a bone or the like in the body, the signal level of the part including the auxiliary device or the fitting became lower than that of the part around it. It was, therefore, difficult in some cases to properly carry out the above-stated image processing such as gradation processing.

For example, a radiographic chest image as a photograph of the chest was composed of image areas the pulmonary field readily transmitting radiations and showing high density values and image areas of mediastinal parts hardly transmitting radiations and showing low density values, so that the dynamic range was very wide of the density values of pixels constituting the radiographic image. It was thus considered to be difficult to obtain an image allowing both the pulmonary field and the mediastinal parts to be observed simultaneously in good order on the same radiographic chest image.

A conventional method for solving the above problem was a process for compensating the radiographic image by use of a filter called "self-compensating digital filter" (Mitsuhiro Anan et al., JAPANESE JOURNAL OF RADIOLOGICAL TECHNOLOGY, Vol 45, No. 8 (Aug 1989), p1030) so as to improve the image area desired to be observed by a doctor (the area of interest).

The self-compensating digital filter described itu above is a filter defined by Eq. (1) and Eq. (2) below:

$$S_D = S_{org} + f(S_{US}) \qquad (1)$$

$$S_{US} = \sum (S_{org} / M^2) \qquad (2)$$

where S_D is a pixel value after the compensation (after the processing), S_{org} is an original (input) image value, S_{US} is an average pixel value obtained in such a way that a mask having the size of M pixels×M pixels is moved on an original image (input image) and an average of pixel values existing in the mask is calculated at each moving portion, and f(x) is a function to represent the function curve as illustrated in FIG. 1.

Described below are characteristics of the function $f(S_{US})$ as illustrated in FIG. 1. Let "BASE" in the figure be a density reference value and "SLOPE" be a compression factor. First, the function $f(S_{US})$ is "0" in the density region of pixel values of "S_{US}>BASE", and the function $f(S_{US})$ monotonically decreases at the rate of the compression factor "SLOPE" down to the end point of the density reference value "BASE" in the density region of pixel values of "$0 \leqq S_{US} \leqq$ BASE". The following effect is thus achieved by processing the pixel values S_{org} of the original image by the "self-compensating digital filter" shown in Eq. (1) above; "in an area with a low average density value (average pixel value S_{US}) of image, the density values are increased to compress the dynamic range of the low density area but the contrast of fine structure is maintained in each area, so that the low density area is converted as a whole to a higher-density image with the contrast of the fine structure thereof being maintained".

In the method for compensating the radiographic image using the "self-compensating digital filter" as described above, however, predetermined values that were empirically obtained have been used as the density reference value "BASE" and the compression factor "SLOPE"; therefore, the effect of compression of the dynamic range varied, depending upon the difference in a photographing portion, the physical constitution of the patient being the subject, or a radiation dose of radiations. It was thus very difficult and troublesome to effect the optimum dynamic range compression for every photographing part, for every physical constitution of a patient being the subject, or for every radiation dose of radiations.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a radiographic, digital image processing system that can solve the above problems.

Another object of the present invention is to provide a radiographic, digital image processing system that can generate a characteristic amount corresponding to a location of a photosensor on a radiographic, digital image without troubling the operator.

In order to accomplish the above object, an embodiment of the present invention is a radiographic, digital image processing system for processing a radiographic, digital image, comprising: photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity during radiography on a radiographic, digital image obtained by the radiography; and characteristic amount generating means for generating a characteristic amount in the image area corresponding to the location of the photosensor on the radiographic, digital image defined by said photosensor area defining means.

Another object of the present invention is to provide a radiographic, digital image processing system that can automatically effect the optimum image processing on a radiographic, digital image without troubling the operator.

In order to accomplish the above object, an embodiment of the present invention is a radiographic, digital image processing system for processing a radiographic, digital image, comprising: input means for inputting radiographic, digital image data digitized from an image obtained by radiography; setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means; photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity of radiations during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the type of the generating source set by said setting means; characteristic amount calculating means for calculating a characteristic amount in the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means; discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means; output device selecting means for selecting a type of an output device of the radiographic, digital image; image processing means for effecting density and/or gradation conversion processing according to the information concerning the type of the generating source set by said setting means, information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, information concerning the photographing portion discriminated by said discriminating means, and information concerning the characteristic amount calculated by said characteristic amount calculating means; and image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

Another object of the present invention is to provide a radiographic, digital image processing system that can effect the optimum image processing on a radiographic, digital image without troubling the operator and without causing a malfunction.

In order to accomplish the above object, an embodiment of the present invention is a radiographic, digital image processing system for processing a radiographic, digital image, comprising: input means for inputting radiographic, digital image data digitized from an image obtained by radiography; setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means; photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity of radiations during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the type of the generating source set by said setting means; subject area extracting means for extracting an image area of a subject on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means and outputting information concerning the image area of the subject; photosensor area correcting means for correcting the image area corresponding to the location of the photosensor on the radiographic, digital image defined by said photosensor area defining means, according to the information concerning the image area of the subject outputted from said subject area extracting means; characteristic amount calculating means for calculating a characteristic amount in the image area corrected by said photosensor area correcting means; discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means; output device selecting means for selecting a type of an output device of the radiographic, digital image; image processing means for effecting density and/or gradation conversion processing according to the information concerning the type of the generating source set by said setting means, information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, information concerning the photographing portion discriminated by said discriminating means, and information concerning the characteristic amount calculated by said characteristic amount calculating means; and image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

Another object of the present invention is to provide a radiographic, digital image processing system that can automatically effect the optimum image processing according to a type of a generating source on a radiographic, digital image without troubling the operator.

In order to accomplish the above object, an embodiment of the present invention is a radiographic, digital image processing system for processing a radiographic, digital image, comprising: input means for inputting radiographic, digital image data digitized from an image obtained by radiography; setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means; photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity of radiations during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the type of the generating source set by said setting means; characteristic amount calculating means for calculating a characteristic amount in the image area corresponding to the location of the photosensor on the radiographic, digital image, according to a histogram of pixel values in the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means; image processing means for effecting density and/or gradation conversion processing according to the information concerning the type of the generating source set

by said setting means and information concerning the characteristic amount calculated by said characteristic amount calculating means; and image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

Another object of the present invention is to provide a radiographic, digital image processing system that can automatically and optimally effecting density and/or gradation conversion processing on a radiographic, digital image without troubling the operator.

In order to accomplish the above object, an embodiment of the present invention is a radiographic, digital image processing system for processing a radiographic, digital image, comprising: input means for inputting radiographic, digital image data digitized from an image obtained by radiography; photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity of radiations during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means; characteristic amount calculating means for calculating a characteristic amount in the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means; image processing means for effecting density and/or gradation conversion processing according to information concerning the characteristic amount calculated by said characteristic amount calculating means, on the radiographic, digital image data inputted by said input means; and image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

Another object of the present invention is to provide a radiographic, digital image processing system that can automatically effect weighted image processing on a radiographic, digital image without troubling the operator.

In order to accomplish the above object, an embodiment of the present invention is a radiographic, digital image processing system for processing a radiographic, digital image, comprising: detecting means disposed at a predetermined location for detecting intensity of radiations at a subject during radiography; input means for inputting image data obtained by said radiography; area defining means for defining an image area corresponding to the location of said detecting means on an image of the image data inputted by said input means; weighting means for calculating a value of each pixel value in the image area defined by said area defining means, multiplied by a predetermined weighting factor; and image processing means for effecting density and/or gradation conversion processing according to the weighted value by said weighting means, on the image data inputted by said input means.

Still another object of the present invention is to provide a radiographic, digital image processing system that can automatically and optimally control a dynamic range of a radiographic, digital image without troubling the operator.

In order to accomplish the above object, an embodiment of the present invention is a radiographic, digital image processing system for processing a radiographic, digital image, comprising: input means for inputting radiographic, digital image data digitized from an image obtained by radiography; photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means; characteristic amount generating means for generating a characteristic amount in the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means; image processing means for effecting image processing to control a dynamic range of the radiographic, digital image indicated by the radiographic, digital image data, on the radiographic, digital image data inputted by said input means, according to information concerning the characteristic amount generated by said characteristic amount generating means; and image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

The other objects and features of the present invention than those described above will become more apparent by the detailed description of the embodiments of the invention referring to the drawings which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a drawing for explaining the conventional, dynamic range compression method;

FIG. 2 is a block diagram to show the schematic structure of a radiographic, digital image processing system as a first embodiment of the present invention;

FIG. 3 is a diagram for explaining set positions of photosensors in a radiographic image taking apparatus in the radiographic, digital image processing system illustrated in FIG. 2;

FIG. 4 is a diagram for explaining density conversion characteristics of data stored in a look-up table (LUT) in an image processing portion of the radiographic, digital image processing system Illustrated in FIG. 2;

FIG. 5 is a block diagram to show the schematic structure of a radiographic, digital image processing system as a second embodiment of the present invention;

FIG. 6 is a diagram for explaining an extraction processing operation of information data concerning an image area corresponding to a subject area in a subject area extracting portion of the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 7 is a diagram for explaining another method of the extraction processing operation of information data concerning an image area corresponding to a subject area in the subject area extracting portion of the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 8 is a diagram for explaining a correction operation of information data concerning an image area corresponding to a position of a photosensor in a photosensor area correcting portion of the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 9 is a diagram for explaining the set positions of the photosensors in the radiographic image taking apparatus in the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 10 is a diagram for explaining density conversion characteristics of data stored in the look-up table (LUT) in the image processing portion of the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 11 is a diagram for explaining a characteristic amount calculating operation in a characteristic amount calculating portion where the subject is a normal patient, in the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 12 is a diagram for explaining the characteristic amount calculating operation in the characteristic amount calculating portion where the subject is a patient provided with a radiation-absorbing auxiliary device such as a pacemaker or a fitting for fixing a bone or the like in the body, in the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 13 is a diagram for explaining the set position of the photosensor in the radiographic image taking apparatus for photography of the abdominal part in the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 14 is a diagram for explaining the set positions of the photosensors in the radiographic image taking apparatus for photography of the chest part in the radiographic, digital image processing system illustrated in FIG. 5;

FIG. 15 is a block diagram to show the schematic structure of a radiographic, digital image processing system as a third embodiment of the present invention;

FIG. 16 is a diagram for explaining an example of weighting factors;

FIG. 17 is a diagram for explaining another example of weighting factors;

FIG. 18 is a diagram for explaining the set positions of the photosensors in the radiographic image taking apparatus in the radiographic, digital image processing system illustrated in FIG. 15;

FIG. 19 is a characteristic diagram for explaining correction of a density conversion curve;

FIG. 20 is a block diagram to show the schematic structure of a radiographic, digital image processing system as a fourth embodiment of the present invention;

FIG. 21 is a diagram for explaining the set position of the photosensor in the radiographic image taking apparatus for photography of the abdominal part in the radiographic, digital image processing system illustrated in FIG. 20;

FIG. 22 is a diagram for explaining the set positions of the photosensors in the radiographic image taking apparatus for photography of the chest part in the radiographic, digital image processing system illustrated in FIG. 20;

FIG. 23 is a diagram to show an example of the schematic structure of the image processing portion in the radiographic, digital image processing system illustrated in FIG. 20;

FIG. 24 is an explanatory diagram to explain the pixel density conversion characteristics on the occasion of photography of the front of the chest part;

FIG. 25 is an explanatory diagram to explain the pixel density conversion characteristics on the occasion of photography of the side of the chest part;

FIG. 26 is a diagram to show another example of the schematic structure of the image processing portion in the radiographic, digital image processing system illustrated in FIG. 20;

FIG. 27 is an explanatory diagram to explain the pixel density conversion characteristics on the occasion of photography of the front of the chest part; and

FIG. 28 is an explanatory diagram to explain the pixel density conversion characteristics on the occasion of photography of the side of the chest part.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

The present invention will be described in detail, based on the radiographic, digital image processing system as a first embodiment of the present invention.

FIG. 2 is a diagram to show the schematic structure of the radiographic, digital image processing system as the first embodiment of the present invention.

In FIG. 2, reference numeral 10 designates an image data generating portion for outputting radiographic, digital image data to a subsequent image storage portion 11, the image data generating portion 10 being, for example, a radiographic image taking apparatus arranged in such structure that radiations such as X-rays are radiated onto the subject, a radiographic image as a transmitted image thereof is picked up directly by a solid state image sensing device, and the apparatus outputs radiographic, digital image data corresponding to the radiographic image thus picked up. In addition to the above radiographic image taking apparatus, the image data generating portion 10 may be either one selected from a radiographic image reading device for reading a radiographic image accumulated and stored in a photo-stimulable phosphor sheet, a radiographic image taking device for radiating radiations to the subject, receiving the radiographic image of the transmitted image thereof on a fluorescent plate, and converting the received image on the fluorescent plate to radiographic, digital image data by the solid state image sensing device, an input interface for capturing the radiographic, digital image data supplied from a radiographic image taking device connected to a computer network, and so on. Namely, the image data generating portion 10 itself does not have to be a radiographic image taking device, but this portion 10 may also be constructed, for example, in such structure that the radiographic image data representing the radiographic image taken by the radiographic image taking device installed at a hospital or the like in a remote place is inputted through the computer network such as Internet into this radiographic, digital image processing system.

Numeral 11 denotes an image data storage portion for storing the radiographic, digital image data supplied from the image data generating portion 10, the image data storage portion 11 being comprised, for example, of a semiconductor memory, a hard-disk drive device, or the like into which data can be written at high speed.

Numeral 12 represents a setting portion for setting a type of a device outputting the radiographic, digital image data in the image data generating portion 10 and for outputting information data indicating the type of the device thus set to a subsequent photosensor area defining portion 15 and to a subsequent image processing portion 17. The setting portion 12 is configured so that the operator himself directly manually sets the type of the device outputting the radiographic, digital image data by manipulating a button or a dial or the like provided in a control panel or by manipulating a keyboard or a mouse or the like as an input device of computer. The radiographic, digital image data is accompanied with information concerning a device generating the radiographic, digital image data, for example, in DICOM, which is the standards of digital picture communication in the medical treatment field. Therefore, in the case where the radiographic, digital image data outputted from the image data generating portion 10 or from the image data storage portion 11 is accompanied with the information concerning the device generating the radiographic, digital image data, the setting portion 12 is configured so as to discriminate the type of the device outputting the radiographic, digital image data according to the accompanying information and automatically set the type of the device.

Numeral 13 denotes a discriminating portion for discriminating a kind of a portion indicated by the radiographic, digital image data outputted from the image data generating

portion 10 and for outputting information data indicating the kind of the portion thus discriminated to the subsequent image processing portion 17. The discriminating portion 13 is configured so that the operator himself directly and manually sets the kind of the portion indicated by the radiographic, digital image data by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer. The radiographic, digital image data is accompanied with the information concerning the kind of the portion indicated by the radiographic, digital image data, for example, in DICOM, which is the standards of digital picture communication in the medical treatment field. Therefore, in the case where the radiographic, digital image data outputted from the image data generating portion 10 is accompanied with the information concerning the kind of the portion indicated by the radiographic, digital image data, the discriminating portion 13 is configured so as to discriminate the kind of the portion indicated by the radiographic, digital image data according to the accompanying information and automatically set the kind of the portion.

Numeral 14 indicates an output device selecting portion for selecting an output device used for outputting the radiographic, digital image data out of a plurality of output devices such as the CRT display device and the film imager device or the dry printer device and for outputting information indicating a type of an output device selected to the subsequent image processing portion 17. The output device selecting portion 14 is configured so that the operator himself directly and manually selects a device used out of the plurality of output devices by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer. For example, where the output device to be used is preset based on the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion 12, the output device selecting portion 14 is configured so as to automatically select the output device preliminarily set based on the information concerning the type of the device outputting the radiographic, digital image data, without forcing the operator himself to directly manually select the type of the device by manipulating the button, the dial, or the like as described above.

Numeral 15 represents a photosensor area defining portion having a memory table which stores information concerning locations of photosensors of radiographic, digital image taking apparatus corresponding to types of radiographic, digital image taking apparatus set in the setting portion 12, the photosensor area defining portion 15 being arranged to read information concerning an image area corresponding to the position of the photosensor on a radiographic, digital image from the memory table, based on the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion 12, and to output the read information to a subsequent characteristic amount calculating portion 16.

The photosensor is a sensor for detecting the intensity of radiations radiated during radiography, and the radiographic image taking apparatus is arranged to control the radiant intensity of radiations according to the intensity of radiations detected by the photosensor so that exposure during radiography becomes as desired. For example, where the radiographic image taking apparatus is one for photography of the chest part, the photosensor is located at the position where it touches the chest of the patient being the subject, and the position and shape of the photosensor thus located are visually displayed on a radiation receiving plate in order to allow the operator to guide the patient to a standing position. The operator adjusts the standing position of the patient so that the chest of the patient touches the display. Then the operator photographs the chest of the patient, whereby the radiant intensity of radiations can be controlled so that the exposure during radiography is appropriate in the area around the lung. In this case, the image area corresponding to the position of the photosensor on the radiographic, digital image is coincident with the display.

The information concerning the image area corresponding to the position of the photosensor on the radiographic, digital image, outputted from the photosensor area defining portion 15 to the characteristic amount calculating portion 16, is image data corresponding to the image area directly cut out of the radiographic, digital image or information data indicating coordinates that represent the position of the image area on the radiographic, digital image.

Incidentally, the image area corresponding to the position of the photosensor on the radiographic, digital image does not always have to be changed among the radiographic devices, but a common area may be employed to the radiographic image taking devices. Further, the image area corresponding to the position of the photosensor on the radiographic, digital image does not always have to coincide perfectly with the shape and position of the photosensor actually disposed, but may have some difference from the actual shape and position.

The aforementioned photosensor area defining portion 15 may also be configured so that it is provided with a memory table which stores information concerning locations of photosensors of radiographic, digital image taking apparatus corresponding to kinds of photographing portions discriminated in the discriminating portion 13 and the defining portion 15 is arranged to read the information concerning the image area corresponding to the position of the photosensor on the radiographic, digital image from the memory table, based on the information concerning the kind of the photographing portion discriminated in the discriminating portion 13, and to output the information thus read to the subsequent characteristic amount calculating portion 16.

Numeral 16 designates the characteristic amount calculating portion for calculating information concerning a characteristic amount such as the maximum, the minimum, the average, the median, the mode, and the like of pixel values in the image area, based on the radiographic, digital image data outputted from the image storage portion 11 and the information data concerning the image area corresponding to the position of the photosensor on the radiographic, digital image indicated by the radiographic, digital image data outputted from the image storage portion, which is outputted from the photosensor area defining portion 15, the characteristic amount calculating portion 16 outputting information data concerning the characteristic amount thus calculated to the subsequent image processing portion 17.

Numeral 17 denotes the image processing portion for performing the image processing operation on the radiographic, digital image data stored in the image storage portion 11 so that the image area corresponding to the position of the photosensor has the optimum density and/or gradation, based on the information indicating the type of the radiographic apparatus, outputted from the setting portion 12, the information concerning the photographing portion, outputted from the discriminating portion 13, the information indicating the type of the output device, out-

putted from the output device selecting portion 14, and the information concerning the characteristic amount of the radiographic, digital data, outputted from the characteristic amount calculating portion 16.

Numeral 18 represents an image output portion, which is the output device such as the CRT display device, the film imager device, or the dry printer device, or the interface or the like for outputting the radiographic, digital image supplied from the image processing portion 17 to the output device connected to the computer network, as described previously. Namely, the image output portion 18 itself does not have to be an output device, but the output portion may be constructed, for example, in such structure that the radiographic image data is supplied via the computer network such as Internet to an output device installed at a remote hospital or the like.

Now, the operation of this radiographic, digital image processing system will be described in detail, using an example in which the chest part of the patient is photographed using the radiographic, digital image taking device having the photosensors at the positions illustrated in FIG. 3 and in which the radiographic, digital image photographed is outputted in a printed form on a film.

In FIG. 3, numeral 20 denotes a chest contact plate of the radiographic, digital image taking apparatus to be in contact with the chest part of the patient being the subject, and the photosensors for detecting the radiation intensity are located in the illustrated areas 21, 22, 23 on the back surface of the chest contact plate.

First, the radiographic, digital image data corresponding to the radiographic image of the chest part of the patient, outputted from the image data generating portion 10 having the radiographic, digital image taking apparatus with the photosensors located at the positions illustrated in FIG. 3, is sent to the image data storage portion 11 and stored in the semiconductor memory, the hard-disk drive device, or the like.

On the other hand, when the chest part of the patient is photographed by the radiographic, digital image taking apparatus of the above-stated type, the photosensor area defining portion 15 reads the information concerning the image areas corresponding to the positions of the photosensors in the radiographic, digital image taking apparatus used for photography (i.e., the information indicating the image areas 21, 23 in FIG. 3), from the memory table storing the information concerning the locations of the photosensors of radiographic, digital image photographing apparatus, according to the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion 12.

The characteristic amount calculating portion 16 cuts the image areas corresponding to the positions of the photosensors, out of the radiographic, digital image data supplied from the image data storage portion 11, calculates a full addition value by adding all pixel values in the image areas thus cut out, calculates an average A by dividing the full addition value thus calculated, by the number of pixels in the image areas corresponding to the positions of the photosensors, and outputs the result to the image processing portion 17.

In the case of this operational example, because the system is so arranged that the setting portion 12 sets the type of the radiographic, digital image taking device used for photography, the discriminating portion 13 discriminates the chest part as a photographing portion, and the output device selecting portion 14 selects the film imager device as an output device, the image processing portion 17 performs the density conversion operation based on a density conversion curve having such density conversion characteristics that the average A supplied as the information concerning the characteristic amount from the characteristic amount calculating portion 16 becomes the optimum density value D on the film finally outputted from the film imager device.

The image processing portion 17 is equipped with the look-up table (hereinafter abbreviated simply as LUT) storing plural data pieces for respective photographing portions, each data piece indicating a density conversion curve as a reference for the density conversion operation. First, the image processing portion 17 reads from the LUT the data concerning the density conversion curve corresponding to the photographing portion discriminated in the discriminating portion 13. Namely, in the case of this operational example, the data indicating the density conversion curve for the "chest part" having the density conversion characteristics as indicated by the thick solid line in FIG. 4, is automatically read from the LUT.

Then the image processing portion 17 moves the density conversion curve indicated by the data read out of the LUT in parallel so that the average A calculated in the characteristic amount calculating portion 16 becomes the density value D. This compensates the density conversion curve to that actually used in the density conversion operation (i.e., to the density conversion curve having such density conversion characteristics as indicated by the thin solid line in FIG. 4).

Then the image processing portion 17 performs the density conversion operation for the digital, radiographic image indicated by the digital, radiographic image data as a photograph of the chest part of the patient, outputted from the image data storage portion 11, according to the density conversion curve thus corrected, and thereafter supplies the digital, radiographic image data undergoing the density conversion operation, to the image output device 18.

The image output device 18 can thus form a digital, radiographic image in the optimum density on the film by printing the digital, radiographic image on the film with laser intensities corresponding to pixel values indicated by the digital, radiographic image data supplied from the image processing portion 17.

The operational example described above was explained as an example where the photographing portion was the "chest", but, for example in the case where the photographing portion is the "abdominal part", the system may be arranged so that the characteristic amount of image is computed from all the image areas corresponding to the positions of the photosensors indicated by 21, 22, 23 in FIG. 3 and the density conversion operation is carried out based on the characteristic amount thus computed. In another case where the photographing portion is either of the "extremities", the system may be arranged so that the characteristic amount of image is computed from only the image area corresponding to the position of the photosensor indicated by 22 in FIG. 3 and the density conversion operation is carried out based on the characteristic amount thus computed. Further, in this case, the radiographic image taking device having the photosensors located at all the positions indicated by 21, 22, 23 in FIG. 3 does not have to be used, but the digital radiography can also be performed by a radiographic image taking device having the photosensor located only at the position indicated by 22 of FIG. 3.

As described above, the present embodiment can provide the radiographic, digital image processing system capable of

automatically performing the optimum image processing operation for the radiographic, digital image without troubling the operator.

Second Embodiment

The present invention will be described in detail, based on the radiographic, digital image processing system as a second embodiment of the present invention.

FIG. 5 is a diagram to show the schematic structure of the radiographic, digital image processing system as the second embodiment of the present invention.

In FIG. 5, reference numeral **110** designates an image data generating portion for outputting radiographic, digital image data to a subsequent image storage portion **111**, the image data generating portion **110** being, for example, a radiographic image taking apparatus arranged in such structure that radiations such as X-rays are radiated onto the subject, a radiographic image as a transmitted image thereof is picked up directly by a solid state image sensing device, and the apparatus outputs radiographic, digital image data corresponding to the radiographic image thus picked up. In addition to the above radiographic image taking apparatus, the image data generating portion **110** may be either one selected from a radiographic image reading device for reading a radiographic image accumulated and stored in a photo-stimulable phosphor sheet, a radiographic image taking device for radiating radiations to the subject, receiving the radiographic image of the transmitted image thereof on a fluorescent plate, and converting the received image on the fluorescent plate to radiographic, digital image data by the solid state image sensing device, an input interface for capturing the radiographic, digital image data supplied from a radiographic image taking device connected to a computer network, and so on. Namely, the image data generating portion **110** itself does not have to be a radiographic image taking device, but this portion **110** may also be constructed, for example, in such structure that the radiographic image data representing the radiographic image taken by the radiographic image taking device installed at a hospital or the like in a remote place is inputted through the computer network such as Internet into this radiographic, digital image processing system.

Numeral **111** denotes an image data storage portion for storing the radiographic, digital image data supplied from the image data generating portion **110**, the image data storage portion **111** being comprised, for example, of a semiconductor memory, a hard-disk drive device, or the like into which data can be written at high speed.

Numeral **112** represents a setting portion for setting a type of a device outputting the radiographic, digital image data in the image data generating portion **110** and for outputting information data indicating the type of the device thus set to a subsequent photosensor area defining portion **115** and to a subsequent image processing portion **119**. The setting portion **112** is configured so that the operator himself directly manually sets the type of the device outputting the radiographic, digital image data by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer. The radiographic, digital image data is accompanied with information concerning a device generating the radiographic, digital image data, for example, in DICOM, which is the standards of digital picture communication in the medical treatment field. Therefore, in the case where the radiographic, digital image data outputted from the image data generating portion **110** or from the image data storage portion **111** is accompanied with the information concerning the device generating the radiographic, digital image data, the setting portion **112** is configured so as to discriminate the type of the device outputting the radiographic, digital image data according to the accompanying information and automatically set the type of the device.

Numeral **113** denotes a discriminating portion for discriminating a kind of a portion indicated by the radiographic, digital image data outputted from the image data generating portion **110** and for outputting information data indicating the kind of the portion thus discriminated to the subsequent image processing portion **119**. The discriminating portion **113** is configured so that the operator himself directly and manually sets the kind of the portion indicated by the radiographic, digital image data by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer. The radiographic, digital image data is accompanied with the information concerning the kind of the portion indicated by the radiographic, digital image data, for example, in DICOM, which is the standards of digital picture communication in the medical treatment field. Therefore, in the case where the radiographic, digital image data outputted from the image data generating portion **110** is accompanied with the information concerning the kind of the portion indicated by the radiographic, digital image data, the discriminating portion **113** is configured so as to discriminate the kind of the portion indicated by the radiographic, digital image data according to the accompanying information and automatically set the kind of the portion.

Numeral **114** indicates an output device selecting portion for selecting an output device used for outputting the radiographic, digital image data out of a plurality of output devices such as the CRT display device and the film imager device or the dry printer device and for outputting information indicating a type of an output device selected to the subsequent image processing portion **119**. The output device selecting portion **114** is configured so that the operator himself directly and manually selects a device used out of the plurality of output devices by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer. For example, where the output device to be used is preset based on the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion **112**, the output device selecting portion **114** is configured so as to automatically select the output device preliminarily set based on the information concerning the type of the device outputting the radiographic, digital image data, without forcing the operator himself to directly manually select the type of the device by manipulating the button, the dial, or the like as described above.

Numeral **115** represents a photosensor area defining portion having a memory table which stores information concerning an image area corresponding to the location, size, shape, etc. of the photosensor of radiographic, digital image taking apparatus corresponding to types of radiographic, digital image taking apparatus set in the setting portion **112**, the photosensor area defining portion **115** being arranged to read information concerning an image area corresponding to the location, size, shape, etc. of the photosensor on the radiographic, digital image from the memory table, based on the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion

112, and to output the read information to a subsequent photosensor area correcting portion 117.

The photosensor is a sensor for detecting the intensity of radiations radiated during radiography, and the radiographic image taking apparatus is arranged to control the radiant intensity and time of radiations according to the intensity of radiations detected by the photosensor so that exposure during radiography becomes as desired.

For example, in the case where the radiographic image taking apparatus is one for photography of the chest part, the photosensor is located at the position where it touches the chest of the patient being the subject, and the position and shape of the photosensor thus located are visually displayed on a radiation receiving plate in order to allow the operator to guide the patient to a standing position. The operator adjusts the standing position of the patient so that the chest of the patient touches the display. Then the operator photographs the chest of the patient, whereby the radiant intensity and time of radiations can be controlled so that the exposure during radiography is appropriate in the area around the lung.

When the radiographic image apparatus is one for photography of the abdominal part, as illustrated in FIG. 13, a photosensor is located at a position where it touches the abdomen of the patient being the subject (indicated by 191 in the figure) and a display is given to show an image area (for example, a rectangular area 40 mm wide and 40 mm long indicated by 192 in the figure) to visually indicate the position and shape of the photosensor placed on the radiation receiving plate in order to permit the operator to guide the patient to the standing position. After the operator adjusts the standing position of the patient so that the abdomen of the patient touches the display, the operator carries out photography. Therefore, the radiant intensity and time of radiations can be controlled so that the exposure during radiography becomes appropriate in the area around the abdomen.

In the above-stated case, the image area corresponding to the position of the photosensor on the radiographic, digital image is coincident with the display. However, the radiographic image device for photography of the chest part may also be arranged as illustrated in FIG. 14. In the apparatus of FIG. 14, in order to make it easier for the operator to guide the patient to the standing position, on the radiation receiving plate, on which the chest of the patient being the subject is placed, there are displays of image areas to visually indicate positions and shapes of rectangular photosensors 50 mm wide and 90 mm long, one at a position on the center line of the receiving plate (1103 in the figure) and two at positions 20 mm apart each from the center line (1101, 1102 in the figure), and a photosensor located at a position (1104 in the figure) overlapping with the image area 1103 of the photosensor. After the operator adjusts the standing position of the patient so that the abdomen of the patient touches the displays, the operator carries out photography. The radiant intensity and time of radiations are controlled so that the exposure during radiography becomes proper in the area around the abdomen. In this apparatus, all the image areas indicating the positions of photosensors on the radiographic, digital image do not coincide with the image area of the photosensor actually set, and no photosensor is actually set in the image areas of 1101, 1102 in the figure. This apparatus may be used for the photography.

Namely, radiographic technicians, who are operators of the radiographic, digital image processing system, are guided to take a photograph in such a state that the part of the patient to be photographed is placed on the display of location of the photosensor on the occasion of radiography. It is thus normal practice to carry out radiography after leading the patient so that the part of the patient being the subject is coincident with the position where the photosensor is located. In the radiographic, digital image processing system of the embodiment of the present invention, the image processing is carried out so as to optimize the density and/or the gradation in the image area corresponding to the location of the photosensor on the radiographic, digital image by making use of the characteristic amount of the image area corresponding to the location, size, shape, etc. of the photosensor used heretofore in the radiographic apparatus, irrespective of whether photography is carried out using the photosensor, on the occasion of determining the processing conditions in the image processing operation such as the density and/or gradation processing for the radiographic, digital image photographed.

The information concerning the image area corresponding to the position of the photosensor on the radiographic, digital image, outputted from the photosensor area defining portion 115 to the photosensor area correcting portion 117, is image data corresponding to the image area directly cut out of the radiographic, digital image or information data indicating coordinates that represent the position of the image area on the radiographic, digital image.

Incidentally, the image area corresponding to the position of the photosensor on the radiographic, digital image does not always have to be changed among the radiographic devices, but a common area may be employed to the radiographic image taking devices. Further, the image area corresponding to the position of the photosensor on the radiographic, digital image does not always have to coincide perfectly with the shape and position of the photosensor actually disposed, but may have some difference from the actual shape and position.

The aforementioned photosensor area defining portion 115 may also be configured so that it is provided with a memory table which stores information concerning locations of photosensors of radiographic, digital image taking apparatus corresponding to kinds of photographing portions discriminated in the discriminating portion 113 and the defining portion 115 is arranged to read the information concerning the image area corresponding to the position of the photosensor on the radiographic, digital image from the memory table, based on the information concerning the kind of the photographing portion discriminated in the discriminating portion 113, and to output the information thus read to the subsequent photosensor area correcting portion 117.

Numeral 116 designates a subject area extracting portion for calculating a histogram of the radiographic, digital image indicated by the radiographic, digital image data outputted from the image storage means 111, determining a subject area and a through area other than the subject area in the radiographic, digital image from the histogram calculated, thereby extracting information data concerning an image area corresponding to the subject area from the radiographic, digital image data, and outputting the information data concerning the image area corresponding to the subject area, thus extracted, to the subsequent photosensor area correcting portion 117. For example, in the histogram of radiographic, digital image as illustrated in FIG. 6, the subject area extracting portion 116 first detects local maximum levels T1, T2 of the histogram and checks whether the positions of the two maximum levels T1, T2 detected are sufficiently apart from each other on the histogram. After confirming it, the subject area extracting portion 116 obtains a level Tmin to

indicate a minimum level f(Tmin) of the histogram between these two maximum levels T1, T2. Using the level Tmin obtained as a boundary (threshold), the image area having the maximum at the maximum level T1 to indicate a level below the level Tmin is determined as the subject area in the radiographic, digital image, while the image area having the maximum at the maximum level T2 to indicate a level over the level Tmin as the through area in the radiographic, digital image, whereby the information data concerning the image area corresponding to the subject area can be extracted from the radiographic, digital image data.

Another extracting method of the information data concerning the image area corresponding to the subject area in the above subject area extracting portion **116** is, for example, a method for, as illustrated in FIG. **7**, detecting a lateral profile **131** at an arbitrary position A on the radiographic, digital image, defining positions where the level changes over a certain threshold, as contour points **132**, **133** of the subject area, repeating the same operation at predetermined intervals in the vertical direction, and connecting the contour points, thereby extracting the information data concerning the inside of the image area surrounded by straight lines **134**, as the information data concerning the image area corresponding to the subject area.

Numeral **117** designates the photosensor area correcting portion for comparing the information data concerning the image area corresponding to the position of the photosensor, outputted from the photosensor area defining portion **115**, with the image area corresponding to the subject area, outputted from the subject area extracting portion **116**, and for correcting the information data concerning the image area corresponding to the position of the photosensor when there is deviation between the image area corresponding to the position of the photosensor and the image area corresponding to the subject area. For example, when the image area **141** corresponding to the position of the photosensor (the rectangular area within the black frame) does not perfectly overlap with the image area **142** corresponding to the subject area (the blank area) to have small deviation, as illustrated in FIG. **8**, the photosensor area correcting portion **117** corrects the information data concerning the image area corresponding to the position of the photosensor to the information data representing the image area of the shape as indicated by the hatched portion **143** of FIG. **8**, and then outputs the image data corresponding to the image area of the photosensor, thus corrected, or the information data indicating coordinates of each vertex of the image area to the subsequent characteristic amount calculating portion **118**.

As described above, the as-corrected image area corresponding to the position of the photosensor indicated by the hatched portion **143** of FIG. **8** is polygonal, but it may be corrected to information indicating a rectangular image area inscribed in the polygonal image area in order to facilitate processing in the subsequent characteristic amount calculating portion **118**.

Numeral **118** designates the characteristic amount calculating portion for selecting as a characteristic amount at least either one of the maximum, the minimum, the average, the median, the mode, etc. of pixel values in the image area and calculating information concerning the characteristic amount, based on the radiographic, digital image data outputted from the image storage portion **111** and the information data concerning the image area corresponding to the position of the photosensor on the radiographic, digital image indicated by the radiographic, digital image data outputted from the image storage portion **111**, outputted from the photosensor area correcting portion **117**, the characteristic amount calculating portion **118** outputting the information data concerning the characteristic amount thus calculated to the subsequent image processing portion **119**.

When there are plural (three) image areas corresponding to the positions of the photosensors as in the case where the photographing portion is the chest part of the patient, the above characteristic amount calculating portion **118** may also be arranged, for example, to calculate as the information data concerning the characteristic amount the maximum and minimum, or the average of each of the three image areas and output the information data calculated to the subsequent image processing portion **119**.

Incidentally, the information concerning the characteristic amount, calculated in the above characteristic amount calculating portion **118**, is calculated based on the histogram of pixel values in the image area corresponding to the position of the photosensor on the radiographic, digital image. Namely, the histogram of pixel values in the image area corresponding to the position of the photosensor on the radiographic, digital image becomes one as illustrated in FIG. **11** where the subject is a normal patient. In this case, the pixel level T providing the maximum f(T) of frequency is computed as the information concerning the characteristic amount, for example.

When the subject is a patient provided with the radiation-absorbing auxiliary device such as a pacemaker or a fitting for fixing the bone or the like in the body and when an image area of the auxiliary device such as the pacemaker or the fitting for fixing the bone or the like is present inside or near the image area corresponding to the position of the photosensor, the histogram, however, is a bimodal histogram as illustrated in FIG. **12**. Therefore, the characteristic amount calculating portion **118** first detects local maximum levels T1, T2 of the histogram in the bimodal histogram as illustrated in FIG. **12** and checks whether locations of the two maximum levels T1, T2 detected are sufficiently apart from each other on the histogram. After confirming it, the characteristic amount calculating portion **118** obtains the level Tmin to indicate the minimum level f(Tmin) of the histogram between these two maximum levels T1, T2.

Incidentally, the auxiliary device such as the pacemaker or the fitting for fixing the bone or the like generally has low transmittance of radiations (i.e., high absorptance of radiations). Using the level Tmin obtained as described above, as a border (threshold), an image area having the maximum at the maximum level T1 to indicate a level below the level Tmin in the histogram is defined as an area in which the auxiliary device or the fitting exists in the radiographic, digital image, while an image area having the maximum at the maximum level T2 to indicate a level over the level Tmin is defined as an area in which the auxiliary device or the fitting does not exist in the radiographic, digital image, whereby the image area except for the area including the auxiliary device or the fitting can be extracted from the radiographic, digital image data. The information concerning the characteristic amount is calculated based on the histogram of pixel values in the image area thus extracted and the information concerning the characteristic amount calculated is outputted to the subsequent image processing portion **119**. This permits the subsequent image processing portion **119** to carry out the appropriate image processing for the radiographic, digital image data stored in the image storage portion **111** so that the image area corresponding to the position of the photosensor has the optimum density and/or gradation without being affected by the auxiliary device such as the pacemaker or the fitting for fixing the bone or the like, in the case where the subject is the patient

provided with the radiating-absorbing auxiliary device such as the pacemaker or the fitting for fixing the bone or the like.

Numeral **119** denotes the image processing portion for performing the image processing operation on the radiographic, digital image data stored in the image storage portion **111** so that the image area corresponding to the position of the photosensor has the optimum density and/or gradation, based on the information indicating the type of the radiographic apparatus, outputted from the setting portion **112**, the information concerning the photographing portion, outputted from the discriminating portion **113**, the information indicating the type of the output device, outputted from the output device selecting portion **114**, and the information concerning the characteristic amount of the radiographic, digital data, outputted from the characteristic amount calculating portion **118**.

Numeral **120** represents an image output portion, which is the output device such as the CRT display device, the film imager device, or the dry printer device, or the interface or the like for outputting the radiographic, digital image supplied from the image processing portion **119** to the output device connected to the computer network, as described previously. Namely, the image output portion **120** itself does not have to be an output device, but the output portion may be constructed, for example, in such structure that the radiographic image data is supplied from this radiographic, digital image processing system via the computer network such as Internet to an output device installed at a remote hospital or the like.

Now, the operation of this radiographic, digital image processing system will be described in detail, using an example in which the chest part of the patient is photographed using the radiographic, digital image taking device having the photosensors at the positions illustrated in FIG. 9 and in which the radiographic, digital image photographed is outputted in a printed form on a film.

In FIG. 9, numeral **150** denotes a chest contact plate of the radiographic, digital image taking apparatus to be in contact with the chest part of the patient being the subject, and the photosensors for detecting the radiation intensity are located in the illustrated areas **151**, **152**, **153** on the back surface of the chest contact plate.

First, the radiographic, digital image data corresponding to the radiographic image of the chest part of the patient, outputted from the image data generating portion **110** having the radiographic, digital image taking apparatus with the photosensors located at the positions illustrated in FIG. 9, is sent to the image data storage portion **111** and stored in the semiconductor memory, the hard-disk drive device, or the like.

On the other hand, when the chest part of the patient is photographed by the radiographic, digital image taking apparatus of the above-stated type, the photosensor area defining portion **115** reads the information concerning the image areas corresponding to the positions of the photosensors in the radiographic, digital image taking apparatus used for photography (i.e., the information indicating the image areas **151**, **153** in FIG. 9), from the memory table storing the information concerning the locations of the photosensors of radiographic, digital image photographing apparatus, according to the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion **112**, and outputs it to the photosensor area correcting portion **117**.

The subject area extracting portion **116** calculates the histogram of the radiographic, digital image indicated by the radiographic, digital image data outputted from the image storage means **111**, determines the subject area and the through area other than the subject area in the radiographic, digital image from the histogram calculated, thereby extracting the information data concerning the image area corresponding to the subject area from the radiographic, digital image data, and outputs the information data concerning the image area corresponding to the subject area thus extracted to the subsequent photosensor area correcting portion **117**.

Then the photosensor area correcting portion **117** compares the information data concerning the image area corresponding to the position of the photosensor, outputted from the photosensor area defining portion **115**, with the information data concerning the image area corresponding to the subject area, outputted from the subject area extracting portion **116**. When there is deviation between the image area corresponding to the position of the photosensor and the image area corresponding to the subject area, the photosensor area correcting portion **117** corrects the information data concerning the image area corresponding to the position of the photosensor and outputs the corrected information data concerning the image area corresponding to the position of the photosensor to the subsequent characteristic amount calculating portion **118**.

The characteristic amount calculating portion **118** cuts the image area corresponding to the position of the photosensor out of the radiographic, digital image data supplied from the image data storage portion **111**, according to the information data concerning the image area corresponding to the position of the photosensor, outputted from the photosensor area correcting portion **117**, then calculates the full addition value by adding all the pixel values in the image area thus cut out, calculates the average A by dividing the full addition value thus calculated by the number of pixels in the image area corresponding to the position of the photosensor, and outputs the result to the image processing device **119**.

In the case of this operational example, because the system is so arranged that the setting portion **112** sets the type of the radiographic, digital image taking device used for photography, the discriminating portion **113** discriminates the "chest part" as a photographing portion, and the output device selecting portion **114** selects the film imager device as an output device, the image processing portion **119** performs the density conversion operation based on a density conversion curve having such density conversion characteristics that the average A supplied as information concerning the characteristic amount from the characteristic amount calculating portion **118** becomes the optimum density value D on the film finally outputted from the film imager device.

The image processing portion **119** is equipped with the look-up table (hereinafter abbreviated simply as LUT) storing plural data pieces for respective photographing portions, each data piece indicating a density conversion curve as a reference for the density conversion operation. First, the image processing portion **119** reads from the LUT the data concerning the density conversion curve corresponding to the photographing portion discriminated in the discriminating portion **113**. Namely, in the case of this operational example, the data indicating the density conversion curve for the "chest part" having the density conversion characteristics as indicated by the thick solid line in FIG. **10**, is automatically read from the LUT.

Then the image processing portion **119** moves the density conversion curve indicated by the data read out of the LUT in parallel so that the average A calculated in the character-

istic amount calculating portion **118** becomes the density value D. This compensates the density conversion curve to that actually used in the density conversion operation (i.e., to the density conversion curve having such density conversion characteristics as indicated by the thin solid line in FIG. **10**).

Then the image processing portion **119** performs the density conversion operation for the digital, radiographic image indicated by the digital, radiographic image data as a photograph of the chest part of the patient, outputted from the image data storage portion **111**, according to the density conversion curve thus corrected, and thereafter supplies the digital, radiographic image data undergoing the density conversion operation, to the image output device **120**.

The image output device **120** can thus form a digital, radiographic image in the optimum density on the film by printing the digital, radiographic image on the film with laser intensities corresponding to pixel values indicated by the digital, radiographic image data supplied from the image processing portion **119**.

The operational example described above was explained as an example where the photographing portion was the "chest", but, for example in the case where the photographing portion is the "abdominal part", the system may be arranged so that the characteristic amount of image is computed from all the image areas corresponding to the positions of the photosensors indicated by **151**, **152**, **153** in FIG. **9** and the density conversion operation is carried out based on the characteristic amount thus computed. In another case where the photographing portion is either of the "extremitie" and the "cervical vertebrae", the system may be arranged so that the characteristic amount of image is computed from only the image area corresponding to the position of the photosensor indicated by **152** in FIG. **9** and the density conversion operation is carried out based on the characteristic amount thus computed. Further, in this case, the radiographic, digital image taking device having the photosensors located at all the positions indicated by **151**, **152**, **153** in FIG. **9** does not have to be used, but the digital radiography can also be performed by a radiographic, digital image taking device having the photosensor located only at the position indicated by **152** of FIG. **9**.

As described above, the present embodiment can provide the radiographic, digital image processing system capable of automatically performing the optimum image processing operation for the radiographic, digital image without troubling the operator.

Third Embodiment

The third embodiment of the present invention will be described by reference to the drawings.

FIG. **15** is a diagram to show the schematic structure of the radiographic, digital image processing system as the third embodiment of the present invention.

In FIG. **15**, reference numeral **210** designates an input means for outputting radiographic, digital image data to a subsequent storage means **211**, the input means **210** being, for example, a radiographic image taking apparatus arranged in such structure that radiations such as X-rays are radiated onto the subject, a radiographic image as a transmitted image thereof is picked up directly by a solid state image sensing device, and the apparatus outputs radiographic, digital image data corresponding to the radiographic image thus picked up.

In addition to the above radiographic image taking apparatus, this input means **210** may be either one selected from an image reading device for reading an X-ray image accumulated and stored in a photo-stimulable phosphor sheet, a radiographic image taking device for radiating radiations to the subject, receiving the radiographic image of the transmitted image thereof on a fluorescent plate, and converting the received image on the fluorescent plate to radiographic, digital image data by the solid state image sensing device, an input interface for capturing the radiographic, digital image data supplied from a radiographic image taking device connected to a computer network, and so on.

Namely, the input means **210** itself does not have to be a radiographic image taking device, but this input means **210** may also be constructed, for example, in such structure that the radiographic image data representing the radiographic image taken by the radiographic image taking device installed at a hospital or the like in a remote place is inputted through the computer network such as Internet into this radiographic, digital image processing system.

Numeral **211** denotes a storage means **211** for storing the radiographic, digital image data supplied from the input means **210**, the storage means **211** being comprised, for example, of a semiconductor memory, a hard-disk drive device, or the like into which data can be written at high speed.

Numeral **212** represents a setting means for setting a type of a device for setting a type of a generating source of the radiographic, digital image data in the above input means **210** and for outputting information indicating the type of the generating source thus set to a subsequent photosensor area defining means **215** and to a subsequent image processing means **217**.

The setting means **212** is configured so that the operator himself directly manually sets the type of the generating source of the radiographic, digital image data by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer.

The radiographic, digital image data is accompanied with the information concerning the type of the generating source of the radiographic, digital image data, for example, in DICOM, which is the standards of digital picture communication in the medical treatment field. Therefore, in the case where the radiographic, digital image data outputted from the above input means **210** is accompanied with the information concerning the type of the generating source, the setting means **212** may be configured so as to discriminate the type of the generating source according to the accompanying information and automatically set the type of the generating source, as an alternative configuration.

Numeral **213** denotes a discriminating means for discriminating a portion of the subject indicated by the radiographic, digital image data outputted from the input means **210** and for outputting information indicating the portion discriminated to the subsequent photosensor area defining means **215** and to the image processing means **217**.

This discriminating means **213** is configured so that the operator directly and manually sets the kind of the portion indicated by the radiographic, digital image data by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer.

The radiographic, digital image data is accompanied with the information concerning the portion indicated by the radiographic, digital image data, for example, in DICOM, which is the standards of digital picture communication in

the medical treatment field. Therefore, in the case where the radiographic, digital image data outputted from the input means **210** is accompanied with the information concerning the portion indicated by the radiographic, digital image data, the discriminating means **213** may be configured so as to discriminate the portion indicated by the radiographic, digital image data according to the accompanying information and automatically set the kind of the portion as an alternative configuration.

Numeral **214** indicates an output device selecting means for selecting an output device used for outputting the radiographic, digital image data out of a plurality of output devices such as the CRT display device and the film imager device for outputting the data to silver-salt film or the dry printer device and for outputting information indicating a type of an output device selected to the subsequent image processing means **217**.

This output device selecting means **214** is configured so that the operator himself directly and manually selects a device used out of the plurality of output devices by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like.

Alternatively, for example, where the output device to be used is preset based on the information concerning the type of the device outputting the radiographic, digital image data, set in the setting means **212**, the output device selecting means **214** may be configured so as to automatically select the output device preliminarily set based on the information concerning the type of the device outputting the radiographic, digital image data, without forcing the operator to directly manually select the type of the device as described above.

Numeral **215** represents a photosensor area defining means having a memory table which stores information concerning locations of photosensors of radiographic, digital image taking apparatus corresponding to types of radiographic, digital image taking apparatus set in the setting means **212**, the photosensor area defining means **215** being arranged to read information concerning an image area corresponding to the position of the photosensor on a radiographic, digital image from the memory table, based on the information concerning the type of the device outputting the radiographic, digital image data, set in the setting means **212**, and to output the read information to a subsequent weighting means **216**.

The photosensor is a sensor for detecting the intensity of radiations radiated during radiography, and the radiographic, digital image taking apparatus is arranged to control irradiation according to the intensity of radiations detected by the photosensor so that exposure during radiography becomes as desired.

For example, where the radiographic, digital image taking apparatus is one for photography of the chest part, the photosensor is located at the position where it touches the chest of the patient being the subject, and the position and shape of the photosensor thus located are visually displayed on a radiation receiving plate in order to allow the operator to guide the patient to a standing position. The operator can control the radiation intensity so that the exposure during radiography is appropriate in the area around the chest and lung of the patient. In this case, the image area corresponding to the position of the photosensor on the radiographic, digital image is coincident with the display.

The information concerning the image area corresponding to the position of the photosensor on the radiographic, digital image, outputted from the photosensor area defining means **215** to the subsequent weighting means **216**, is image data corresponding to the image area directly cut out of the radiographic, digital image or information indicating coordinates that represent the position of the image area on the radiographic, digital image.

Incidentally, the image area corresponding to the position of the photosensor on the radiographic, digital image does not always have to be changed among the radiographic devices, but a common area may be employed to the radiographic image taking devices. Further, the image area corresponding to the position of the photosensor on the radiographic, digital image does not always have to coincide perfectly with the shape and position of the photosensor actually disposed, but may have some difference from the actual shape and position.

The aforementioned photosensor area defining means **215** may also be configured so that it is provided with a memory table which stores information concerning locations of photosensors of radiographic, digital image taking apparatus corresponding to kinds of photographing portions discriminated in the discriminating means **213** and the defining means **215** is arranged to read the information concerning the image area corresponding to the position of the photosensor on the radiographic, digital image from the memory table, based on the information concerning the kind of the photographing portion discriminated in the discriminating means **213**, and to output the information thus read to the subsequent weighting means **216**.

Numeral **216** designates the weighting means for calculating weighted values from the pixel values in the image area, based on the radiographic, digital image data outputted from the above storage means **211** and the information concerning the image area corresponding to the position of the photosensor on the radiographic, digital image indicated by the radiographic, digital image data outputted from the storage means **211**, outputted from the photosensor area defining means **215**, the weighting means **216** outputting the information concerning the weighted values thus calculated to the subsequent image processing means **217**.

Weighting factors used in this weighting means **216** vary toward the center line or the center point of the image area corresponding to the position of the photosensor, for example. FIG. **16** shows an example in which the weighting factors increase toward the center line and FIG. **17** an example in which the weighting factors increase toward the center point. The pixel values of the image area corresponding to the position of the photosensor are multiplied by these weighting factors corresponding thereto. The values obtained all are added up and the result is divided by the sum of the factors to obtain a weighted value.

These weighting factors may be arranged to be large at high-sensitivity portions but small at low-sensitivity portions, corresponding to sensitivity distribution of the photosensor. The weighted value calculated is outputted to the subsequent image processing means **217**.

Numeral **217** denotes the image processing means for performing the image processing operation on the radiographic, digital image data stored in the storage means **211** so that the image area corresponding to the position of the photosensor has the optimum density and/or gradation, based on the information indicating the type of the generating source of the radiographic, digital image data, outputted from the setting means **212**, the information concerning the portion, outputted from the discriminating means **213**, the information indicating the type of the output device,

outputted from the output device selecting means **214**, and the information of the weighted value or the like of the radiographic, digital image data, outputted from the weighting means **216**.

Numeral **218** represents an image output means, which is the output device such as the CRT display device, the film imager device for outputting the data to the silver-salt film, or the dry printer device, or the interface or the like for outputting the radiographic, digital image supplied from the image processing means **217** to the output device connected to the computer network, as described previously. Namely, the image output means **218** itself does not have to be an output device, but the output mens may be constructed, for example, in such structure that the radiographic, digital image data is outputted via the computer network such as Internet to an output device installed at a remote hospital or the like.

Now, the operation of this radiographic, digital image processing system will be described, using an example in which the chest part is photographed using the radiographic, digital image taking device as illustrated in FIG. **18** and in which the radiographic, digital image photographed is outputted in a printed form on a film.

In FIG. **18**, numeral **240** denotes a chest contact plate of the radiographic, digital image taking apparatus to be in contact with the chest part of the patient being the subject, and the photosensors for detecting the X-ray intensity are located in the illustrated areas **241, 242, 243** on the back surface of the chest contact plate **240**.

First, the radiographic, digital image data corresponding to the radiographic image of the chest part of the patient, outputted from the input means **210** having the radiographic, digital image taking apparatus with the photosensors **241** to **243** located at the positions illustrated in FIG. **18**, is sent to the storage means **211** and stored in the semiconductor memory, the hard-disk drive device, or the like.

On the other hand, when the chest part of the patient is photographed by the radiographic, digital image taking apparatus of the above-stated typė, the photosensor area defining means **215** reads the information concerning the image areas corresponding to the positions of the photosensors in the radiographic, digital image taking apparatus used for photography, i.e., the information indicating the image areas corresponding to the two photosensors **241** and **243** of FIG. **18**, from the memory table storing the information concerning the locations of the photosensors of radiographic, digital image photographing apparatus, according to the information concerning the type of the device outputting the radiographic, digital image data, set in the setting means **212**, and outputs the information to the weighting means **216**.

The weighting means **216** calculates the weighted value A by multiplying the pixel values in the image areas corresponding to the positions of the photosensors, out of the radiographic, digital image data supplied from the storage means **211**, by the factors corresponding to the sensitivity distribution of the photosensors, and outputs the result to the image processing means **217**.

In the case of this operational example, because the system is so arranged that the setting means **212** sets the type of the radiographic, digital image taking device used for photography, the discriminating means **213** discriminates the chest part as a photographing portion, and the output device selecting means **214** selects the film imager device as an output device, the image processing means **217** performs the density conversion operation based on the density conversion table having such density conversion characteristics that the weighted value A supplied from the weighting means **216** becomes the optimum density value D on the film finally outputted from the film imager device.

The image processing means **217** is equipped with the look-up table (hereinafter abbreviated simply as LUT) storing plural data pieces for respective photographing portions, each data piece indicating a density conversion curve as a reference for the density conversion operation. First, the image processing means **217** reads from the LUT the data concerning the density conversion curve corresponding to the photographing portion discriminated in the discriminating means **213**. Namely, in the case of this operational example, the data indicating the density conversion curve for the "chest part" having the density conversion characteristics as indicated by the thick solid line in FIG. **19**, is automatically read from the LUT.

Then the image processing means **217** moves the density conversion curve indicated by the data read out of the LUT in parallel so that the weighted value A calculated in the weighting means **216** becomes the density value D. This compensates the density conversion curve to that actually used in the density conversion operation (indicated by the thin solid line in FIG. **19**).

Then the image processing means **217** carries out the density conversion operation based on the above corrected density conversion curve for the radiographic, digital image data of the photograph of the chest part outputted from the storage means **211** and thereafter supplies the radiographic, digital image data thus processed to the image output means **218**.

The image output means **218** can thus form a digital, radiographic image in the optimum density on the film by printing the digital, radiographic image on the film with laser intensities corresponding to pixel values indicated by the digital, radiographic image data supplied from the image processing means **217**.

The operational example described above was explained as an example where the photographing portion was the "chest", but, for example in the case where the photographing portion is the "abdominal part", the system may be arranged so that the weighted value is computed from all the three image areas corresponding to the photosensors **241** to **243** of FIG. **18** and the density conversion operation is carried out based on the characteristic amount thus computed.

In another case where the photographing portion is either of the "extremities", the system may be arranged so that the weighted value is computed from only the image area corresponding to the position of one photosensor **242** of FIG. **18** and the density conversion operation is carried out based on the characteristic amount thus computed. Further, in this case, the radiographic, digital image taking device having all the photosensors **241** to **243** located does not have to be used, but the radiography can also be performed by a radiographic, digital image taking device having only the photosensor **242**.

Next described is a storage medium as another embodiment of the present invention.

When the system composed of the blocks of FIG. **15** is comprised of a computer system including the CPU and memory, this memory constitutes the storage medium according to the present invention. This storage medium stores a program for carrying out the processing procedures for controlling the above-stated operation.

The storage medium may be selected from a semiconductor memory such as an ROM or an RAM, an optical disk,

a magnetooptical disk, a magnetic medium, and so on, which may be used in the form of a CD-ROM, a floppy disk, a magnetic medium, a magnetic card, a non-volatile memory card, or the like.

Accordingly, this storage medium can be used in another system or apparatus except for the system and apparatus described above in FIG. 15 and the system or computer can read the program code stored in this storage medium to carry out the program, whereby the function and effect equivalent to those in the above embodiment can be implemented, thereby accomplishing the object of the present invention.

The function and effect equivalent to those in the above embodiment can also be implemented so as to accomplish the object of the present invention in the case where the OS or the like operating on the computer executes a part or the whole of the processing or in the case where the program code read out of the storage medium is first written into a memory provided in an extended function board put in the computer or in an extended function unit connected to the computer and thereafter, based on instructions of the program code, the CPU or the like in the above extended function board or in the extended function unit carries out a part or the whole of the processing.

As described above, the present embodiment can provide the radiographic, digital image processing system capable of automatically performing the optimum image processing operation on a portion of the subject in the radiographic, digital image without troubling the operator.

Fourth Embodiment

The present invention will be described in detail, based on the radiographic, digital image processing system as a fourth embodiment of the present invention.

FIG. 20 is a diagram to show the schematic structure of the radiographic, digital image processing system as the fourth embodiment of the present invention.

In FIG. 20, reference numeral 310 designates an image data generating portion for generating radiographic, digital image data, which is, for example, a radiographic image taking apparatus arranged in such structure that radiations such as X-rays are radiated onto the subject, a radiographic image as a transmitted image thereof is picked up directly by a solid state image sensing device, and the apparatus outputs radiographic, digital image data corresponding to the radiographic image thus picked up. In addition to the above radiographic image taking apparatus, the image data generating portion 310 may be either one selected from a radiographic image reading device for reading a radiographic image accumulated and stored in a photo-stimulable phosphor sheet, a radiographic image taking device for radiating radiations to the subject, receiving the radiographic image of the transmitted image thereof on a fluorescent plate, and converting the received image on the fluorescent plate to radiographic, digital image data by the solid state image sensing device, an input interface for capturing the radiographic, digital image data supplied from a radiographic image taking device connected to a computer network, and so on. Namely, the image data generating portion 310 itself does not have to be a radiographic image taking device, but this portion 310 may also be constructed, for example, in such structure that the radiographic image data representing the radiographic image taken by the radiographic image taking device installed at a hospital or the like in a remote place is inputted through the computer network such as Internet into this radiographic, digital image processing system.

Numeral 311 denotes an image data storage portion for storing the radiographic, digital image data supplied from the image data generating portion 310, the image data storage portion 311 being comprised, for example, of a semiconductor memory, a hard-disk drive device, or the like into which data can be written at high speed.

Numeral 312 represents a setting portion for setting a type of a device outputting the radiographic, digital image data in the image data generating portion 310 and for outputting information data indicating the type of the device thus set to a subsequent photosensor area defining portion 315 and to a subsequent image processing portion 317. The setting portion 312 is configured so that the operator himself directly manually sets the type of the device outputting the radiographic, digital image data by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer. The radiographic, digital image data is accompanied with information concerning a device generating the radiographic, digital image data, for example, in DICOM, which is the standards of digital picture communication in the medical treatment field. Therefore, in the case where the radiographic, digital image data outputted from the image data generating portion 310 or from the image data storage portion 311 is accompanied with the information concerning the device generating the radiographic, digital image data, the setting portion 312 is configured so as to discriminate the type of the device outputting the radiographic, digital image data according to the accompanying information and automatically set the type of the device.

Numeral 313 denotes a discriminating portion for discriminating a kind of a portion indicated by the radiographic, digital image data outputted from the image data generating portion 310 and for outputting information data indicating the kind of the portion thus discriminated to the subsequent image processing portion 317. The discriminating portion 313 is configured so that the operator himself directly and manually sets the kind of the portion indicated by the radiographic, digital image data by manipulating the button or the dial or the like provided in the control panel or by manipulating the keyboard or the mouse or the like as an input device of computer. The radiographic, digital image data is accompanied with the information concerning the kind of the portion indicated by the radiographic, digital image data, for example, in DICOM, which is the standards of digital picture communication in the medical treatment field. Therefore, in the case where the radiographic, digital image data outputted from the image data generating portion 310 is accompanied with the information concerning the kind of the portion indicated by the radiographic, digital image data, the discriminating portion 313 is configured so as to discriminate the kind of the portion indicated by the radiographic, digital image data according to the accompanying information and automatically set the kind of the portion.

Numeral 314 indicates an output device selecting portion for selecting an output device used for outputting the radiographic, digital image data out of a plurality of output devices such as the CRT display device and the film imager device or the dry printer device and for outputting information indicating a type of an output device selected to the subsequent image processing portion 317. The output device selecting portion 314 is configured so that the operator himself directly and manually selects a device used out of the plurality of output devices by manipulating the button or the dial or the like provided in the control panel or by

manipulating the keyboard or the mouse or the like as an input device of computer. For example, where the output device to be used is preset based on the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion **312**, the output device selecting portion **314** is configured so as to automatically select the output device preliminarily set based on the information concerning the type of the device outputting the radiographic, digital image data, without forcing the operator himself to directly manually select the type of the device by manipulating the button, the dial, or the like as described above.

Numeral **315** represents a photosensor area defining portion having a memory table which stores information concerning an image area corresponding to the location, size, shape, etc. of the photosensor of radiographic, digital image taking apparatus corresponding to types of radiographic, digital image taking apparatus set in the setting portion **312**, the photosensor area defining portion **315** being arranged to read information concerning an image area corresponding to the location, size, shape, etc. of the photosensor on the radiographic, digital image from the memory table, based on the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion **312**, and to output the read information to a subsequent characteristic amount calculating portion **316**.

The photosensor is a sensor for detecting the intensity of radiations radiated during radiography, and the radiographic image taking apparatus is arranged to control the radiant intensity of radiations according to the intensity of radiations detected by the photosensor so that the exposure during radiography becomes as desired.

For example, in the case where the radiographic image taking apparatus is one for photography of the chest part, the photosensor is located at the position where it touches the chest of the patient being the subject, and the position and shape of the photosensor thus located are visually displayed on a radiation receiving plate in order to allow the operator to guide the patient to a standing position. The operator adjusts the standing position of the patient so that the chest of the patient touches the display. Then the operator photographs the chest of the patient, whereby the radiant intensity of radiations can be controlled so that the exposure during radiography is appropriate in the area around the lung.

When the radiographic image apparatus is one for photography of the abdominal part, as illustrated in FIG. **21**, a photosensor is located at a position where it touches the abdomen of the patient being the subject (indicated by **321** in the figure) and a display is given to show an image area (for example, a rectangular area 40 mm wide and 40 mm long indicated by **322** in the figure) to visually indicate the position and shape of the photosensor placed on the radiation receiving plate in order to permit the operator to guide the patient to the standing position. After the operator adjusts the standing position of the patient so that the abdomen of the patient touches the display, the operator carries out photography. Therefore, the radiant intensity and time of radiations can be controlled so that the exposure during radiography becomes appropriate in the area around the abdomen.

In the above-stated case, the image area corresponding to the position of the photosensor on the radiographic, digital image is coincident with the display. However, the radiographic image device for photography of the chest part may also be arranged as illustrated in FIG. **22**. In the apparatus of FIG. **22**, in order to make it easier for the operator to guide the patient to the standing position, on the radiation receiving plate, on which the chest of the patient being the subject is placed, there are displays of image areas to visually indicate positions and shapes of rectangular photosensors 50 mm wide and 90 mm long, one at a position on the center line of the receiving plate (**333** in the figure) and two at positions 20 mm apart each from the center line (**331, 332** in the figure), and a photosensor located at a position (**334** in the figure) overlapping with the image area **333** of the photosensor. After the operator adjusts the standing position of the patient so that the abdomen of the patient touches the displays, the operator carries out photography. The radiant intensity and time of radiations are controlled so that the exposure during radiography becomes proper in the area around the abdomen. In this apparatus, all the image areas indicating the positions of photosensors on the radiographic, digital image do not coincide with the image area of the photosensor actually set, and no photosensor is actually set in the image areas of **331, 332** in the figure. This apparatus may be used for the photography.

Namely, radiographic technicians, who are operators of the radiographic, digital image processing system, are guided to take a photograph in such a state that the part of the patient to be photographed is placed on the display of location of the photosensor on the occasion of radiography. It is thus normal practice to carry out radiography after leading the patient so that the part of the patient being the subject is coincident with the position where the photosensor is located. In the radiographic, digital image processing system of the embodiment of the present invention, the image processing is carried out so as to optimize the density and/or the gradation in the image area corresponding to the location of the photosensor on the radiographic, digital image by making use of the characteristic amount of the image area corresponding to the location, size, shape, etc. of the photosensor used heretofore in the radiographic apparatus, irrespective of whether photography is carried out using the photosensor, on the occasion of determining the processing conditions in the image processing operation such as the density and/or gradation processing for the radiographic, digital image photographed.

The information concerning the image area corresponding to the location, size, shape, etc. of the photosensor on the radiographic, digital image outputted from the above photosensor area defining portion **315** to the characteristic amount calculating portion **316**, is image data corresponding to the image area directly cut out of the radiographic, digital image or information data indicating coordinates that represent the position of the image area on the radiographic, digital image.

Incidentally, the image area corresponding to the location, size, shape, etc. of the photosensor on the radiographic, digital image does not always have to be changed among the radiographic devices, but a common area may be employed to the radiographic image taking devices. Further, the image area corresponding to the location, size, shape, etc. of the photosensor on the radiographic, digital image does not always have to coincide perfectly with the shape and position of the photosensor actually disposed, but may have some difference from the actual shape and position.

The aforementioned photosensor area defining portion **315** may also be configured so that it is provided with a memory table which stores information concerning the location, size, shape, etc. of photosensor of the radiographic, digital image taking apparatus corresponding to kinds of photographing portions discriminated in the discriminating portion **313** and the defining portion **315** is arranged to read

the information concerning the image area corresponding to the location, size, shape, etc. of the photosensor on the radiographic, digital image from the memory table, based on the information concerning the kind of the photographing portion discriminated in the discriminating portion **313**, and to output the information thus read to the subsequent characteristic amount calculating portion **316**.

Numeral **316** designates the characteristic amount calculating portion for selecting as a characteristic amount at least either one of the maximum, the minimum, the average, the median, the mode, and the like of pixel values in the image area and calculating information concerning the characteristic amount based on the radiographic, digital image data outputted from the image storage portion **311** and the information data concerning the image area corresponding to the location, size, shape, etc. of the photosensor on the radiographic, digital image indicated by the radiographic, digital image data outputted from the image storage portion **311**, outputted from the photosensor area defining portion **315**, the characteristic amount calculating portion **316** outputting the information data concerning the characteristic amount thus calculated to the subsequent image processing portion **317**.

When there are plural (three) image areas corresponding to positions of photosensors as in the case where the photographing portion is the chest part of the patient, the characteristic amount calculating portion **316** may be configured, for example, to calculate the maximum and minimum, or the average of each of the three image areas as the information data concerning the characteristic amount and output the information data calculated to the subsequent image processing portion **317**.

Numeral **317** denotes the image processing portion for performing the image processing operation to compress the dynamic range of the radiographic, digital image data stored in the image storage portion **311** so that the image area corresponding to the position of the photosensor has the optimum density and/or gradation, based on the information indicating the type of the radiographic apparatus, outputted from the setting portion **312**, the information concerning the photographing portion, outputted from the discriminating portion **313**, the information indicating the type of the output device, outputted from the output device selecting portion **314**, and the information concerning the characteristic amount of the radiographic, digital image, outputted from the characteristic amount calculating portion **316**.

Numeral **318** represents an image output portion, which is the output device such as the CRT display device, the film imager device, or the dry printer device, or the interface or the like for outputting the radiographic, digital image supplied from the image processing portion **317** to the output device connected to the computer network, as described previously. Namely, the image output portion **318** itself does not have to be an output device, but the output portion may be constructed, for example, in such structure that the radiographic image data is supplied via the computer network such as Internet to an output device installed at a remote hospital or the like.

Now, the operation of this radiographic, digital image processing system will be described in detail, using an example in which the front or the side of the chest part of the patient is photographed using the radiographic, digital image taking device having the photosensors at the positions illustrated in FIG. **22** and in which the radiographic, digital image photographed is outputted in a printed form on a film.

First, the radiographic, digital image data corresponding to the radiographic image of the front or the side of the chest part, outputted from the image data generating portion **310** having the radiographic, digital image taking apparatus with the photosensor at the position indicated by **334** in FIG. **22**, is sent to the image data storage portion **311** and stored in the semiconductor memory, the hard-disk drive device, or the like.

On the other hand, when the front or the side of the chest part of the patient is photographed by the radiographic, digital image taking apparatus of the above-stated type, the photosensor area defining portion **315** reads the information concerning the image area corresponding to the location, size, shape, etc. of the photosensor in the radiographic, digital image taking apparatus used for photography (i.e., the information indicating the image areas of **331**, **332**, **333** in FIG. **22**), from the memory table storing the information concerning the image area corresponding to the location, size, shape, etc. of the photosensor of radiographic, digital image photographing apparatus, according to the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion **312**, and outputs it to the characteristic amount calculating portion **316**.

The characteristic amount calculating portion **316** cuts each of the image areas corresponding to the positions of the photosensors according to the information outputted from the photosensor area defining portion **315**, out of the radiographic, digital image data supplied from the image data storage portion **311**, calculates an average of pixel values in each image area thus cut out (in this example, an average of pixel values in the image area of **333** in FIG. **22** will be called Cave, an average of pixel values in the image area of **332** Rave, and an average of pixel values in the image area of **331** Lave), and outputs data indicating these values to the image processing portion **317**.

In the case of this operational example, because the system is so arranged that the setting portion **312** sets the type of the radiographic, digital image taking device used for photography, the discriminating portion **313** discriminates the front or the side of the chest part as a photographing portion, and the output device selecting portion **314** selects the film imager device as an output device, the image processing portion **317** carries out such processing as to effect optimum dynamic range compression, using the data indicating the averages supplied from the characteristic amount calculating portion **316**.

FIG. **23** is a diagram to show an example of the schematic structure of the image processing portion **317**.

As illustrated in FIG. **23**, the image processing portion **317** is composed of a density reference value defining portion **341** for defining a density reference value used in the dynamic range compression operation and generating data to indicate the density reference value determined, a compression factor defining portion **342** for defining a compression factor and generating data to indicate the compression factor determined, a smoothing portion **343** for smoothing the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311** and generating data to indicate the radiographic, digital image thus smoothed, and a dynamic range compression processing portion **344** for performing the operation of compressing the dynamic range of the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311**, based on the data to indicate the density reference value, the data to indicate the compression factor, and the data to indicate the smoothed image, supplied from the respective portions.

In the image processing portion **317**, when the front of the chest is discriminated as a photographing portion in the discriminating portion **313**, the density reference value defining portion **341** defines as a density reference value (BASE in FIG. **24**) on the function curve illustrated in FIG. **24**, a value represented by "Cave+(Rave−Cave)×α (where α is an arbitrary constant set according to the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion **312**)", which is located between the average Cave and the average Rave supplied from the characteristic amount calculating portion **316**. The density reference value may be a value represented by "Cave+(Lave−Cave)×α", which is located between the average Cave and the average Lave supplied from the characteristic amount calculating portion **316** or may be a value smaller than the average Cave.

Then the compression factor defining portion **342** defines as a compression factor (SLOPE in the figure) on the function curve illustrated in FIG. **24**, a value represented by "Cave×β/{(Rave−Cave)×α} (where β is an arbitrary constant set according to the information concerning the type of the output device for outputting the radiographic, digital image data, set in the output device selecting portion **314**)" by which pixel values of the image area indicating the average Cave, supplied from the characteristic amount calculating portion **316**, on the radiographic, digital image after the dynamic range compression operation, are increased by the predetermined value β with respect to the density reference value determined in the density reference value defining portion **341**.

The smoothing portion **343** moves a mask of the size having M pixels×M pixels (M is an arbitrary constant) on the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311** and smooths the radiographic, digital image by obtaining an average of pixel values present in the mask at each moving portion and replacing the pixel values used for obtaining the average with the average thus obtained. The smoothing portion **343** generates data indicating the radiographic, digital image thus smoothed or generates data indicating the radiographic, digital image smoothed by use of a morphological filter.

Let S'_{org} represent the pixel values of the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311**, S'_{US} represent the pixel values of the averaged, radiographic, digital image indicated by the data to represent the smoothed image supplied from the smoothing portion **343**, S'_D represent the pixel values of the radiographic, digital image after the dynamic range compression operation, and the function f'(x) represent the function curve representing the pixel density value conversion characteristics as illustrated in FIG. **24** with the parameters of the data representing the density reference value (BASE) obtained from the density reference value defining portion **341** and the data representing the compression factor obtained from the compression factor defining portion **342**. Then the dynamic range compression processing portion **344** executes the operation of compressing the dynamic range of the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311** according to the following arithmetic of Eq. (3).

$$S'_D = S'_{org} + f'(S_{US}) \tag{3}$$

Therefore, the dynamic range compression processing portion **344** can carry out the operation of compressing the dynamic range of the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311**, according to the dynamic range compression characteristics arbitrarily set according to the photographing portion.

In the above image processing portion **317**, when the side of the chest is discriminated as a photographing portion in the discriminating portion **313**, the density reference value defining portion **341** defines as a density reference value (BASE in FIG. **25**) on the function curve illustrated in FIG. **25**, the average Cave supplied from the characteristic amount calculating portion **316**, multiplied by α, Cave×α, (α is an arbitrary constant set according to the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion **312**), and the compression factor defining portion **342** defines as a compression factor (SLOPE in the figure) on the function curve illustrated in FIG. **25**, a value represented by "Rave×β/{(Cave−Rave)×α} (β is an arbitrary constant set according to the information concerning the type of the output device for outputting the radiographic, digital image data, set in the output device selecting portion **314**)" by which pixel values of the image area indicating the average Rave or the average Lave, supplied from the characteristic amount calculating portion **316**, on the radiographic, digital image after the dynamic range compression processing operation, are increased by the predetermined value β with respect to the density reference value defined in the density reference value defining portion **341**. After that, the image processing portion carries out the like operation as in the case of the photographing portion being the front of the chest as described above, whereby the image processing portion can execute the processing operation of compressing the dynamic range of the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311**, according to the dynamic range compression characteristics arbitrarily set according to the photographing portion.

FIG. **26** is a diagram to show another example of the schematic structure of the image processing portion **317**.

As illustrated in FIG. **26**, the image processing portion **317** is composed of a smoothing portion **370** for smoothing the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311** and generating data to indicate the smoothed, radiographic, digital image, a high-frequency image generating portion **371** for generating data to indicate an image of high-frequency components in the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311**, using the radiographic, digital image data supplied from the image data storage portion **311** and the data to indicate the smoothed image, obtained from the smoothing portion **370**, a pixel density value conversion curve defining portion **372** provided with a memory table preliminarily storing function data representing pixel density value conversion characteristics respectively corresponding to types of radiographic devices, photographing portions, and types of output devices, the pixel density value conversion curve defining portion **372** selecting function data representing the pixel density value conversion characteristics according to the information representing the type of the radiographic device, outputted from the setting portion **312**, the information concerning the photographing portion, outputted from the discriminating portion **313**, and the information representing the type of the output device, outputted from the output device selecting portion **314**, from the memory table, adjust-

ing a pixel density value conversion curve indicated by the selected function data to desired characteristics, and outputting data to indicate a pixel density value conversion curve as adjusted, a subject area defining portion **373** for defining a subject area excluding the through portion (an area in which radiations impinge directly on the sensor or the like without passing the subject) in the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311** and generating data to indicate the subject area thus defined, a subject area characteristic amount generating portion **374** for generating data to indicate a characteristic amount of the subject area, based on the data indicating the subject area supplied from the subject area defining portion **373**, a density reference value defining portion **375** for defining a density reference value (BASE) used in the dynamic range compression processing operation, based on the data to indicate the characteristic amount of the subject area, supplied from the subject area characteristic amount generating portion **374**, and generating data to indicate the density reference value thus defined, a compression factor defining portion **376** for defining a compression factor (R), based on the data to indicate the pixel density value conversion curve, the data to indicate the density reference value, and the data to indicate the characteristic amount of the subject area, obtained from the respective portions, and generating data to indicate the compression factor thus defined, and a dynamic range compression processing portion **377** for carrying out the processing operation for compressing the dynamic range of the radiographic, digital image indicated by the radiographic, digital image data supplied from the image data storage portion **311**, based on the data to indicate the density reference value, the data to indicate the compression factor, and the data to indicate the image of high-frequency components, obtained from the respective portions.

In the image processing portion **317**, when the front of the chest is discriminated as a photographing portion in the discriminating portion **313**, the pixel density value conversion curve defining portion **372** first selects function data to indicate pixel density value conversion characteristics (curve) as indicated by the dashed line in FIG. **27**, according to the information indicating the type of the radiographic device (i.e., the information indicating the radiographic, digital image taking device), outputted from the setting portion **312**, the information concerning the photographing portion (i.e., the information indicating the front of the chest), outputted from the discriminating portion **313**, and the information indicating the type of the output device (i.e., the information indicating the film imager device), outputted from the output device selecting portion **314**, from the memory table preliminarily storing the function data to indicate the pixel density value conversion characteristics respectively corresponding to the types of radiographic devices, photographing portions, and types of output devices.

On the other hand, the pixel density value conversion curve defining portion **372** receives the data indicating the averages Cave, Rave, Lave supplied from the characteristic amount calculating portion **316**, then adjusts the pixel density value conversion curve by moving it in parallel in the direction indicated by the arrow in FIG. **27** up to the position indicated by the thin line in FIG. **27** so that the average Rave (or the average Lave) becomes a desired density value D_L of the pulmonary field preliminarily set, on the pixel density value conversion curve as indicated by the dashed line in FIG. **27**, and outputs data to indicate the pixel density value conversion curve thus adjusted, $F_{FRO}(X)$, to the compression factor defining portion **376** and to the dynamic range compression processing means **377**.

The subject area defining portion **373** separates the subject area, which is a transmitted image of the subject excluding the through area where radiations impinge directly on the sensor or the like without passing the subject, from the radiographic image indicated by the radiographic, digital image data supplied from the image data storage portion **311**, and outputs information data to indicate the subject area thus separated to the subsequent subject area characteristic amount generating portion **374**.

Then the subject area characteristic amount generating portion **374** generates a minimum pixel density value S_{min} in the subject area, based on the information data to indicate the subject area supplied from the subject area defining portion **373**, and outputs data to indicate the minimum pixel density value S_{min} thus generated as data to indicate a characteristic amount of the subject area to the compression factor defining portion **376**.

The density reference value defining portion **375** receives the data indicating the averages Cave, Rave, Lave supplied from the characteristic amount calculating portion **316**, calculates the density reference value (BASE) according to Eq. (4) below, and outputs data to indicate the density reference value (BASE) thus calculated to the compression factor defining portion **376** and to the dynamic range compression processing portion **377**.

$$BASE=Cave+(Rave-Cave)\times\alpha \tag{4}$$

In above Eq. (4) a is an arbitrary constant set according to the information concerning the type of the device outputting the radiographic, digital image data, set in the setting portion.

The compression factor defining portion **376** receives the data indicating the adjusted pixel density value conversion curve $F_{FRO}(X)$ indicated by the thin line in FIG. **27**, supplied from the pixel density value conversion curve defining portion **372**, the data indicating the minimum pixel density value S_{min} as a characteristic amount of the subject area from the subject area characteristic amount generating portion **374**, and the data indicating the density reference value (BASE) from the density reference value defining portion **375**. Then the compression factor defining portion **376** calculates the compression factor (R) according to Eq. (5) below, based on the data supplied from the respective portions, and outputs data to indicate the compression factor (R) thus calculated to the dynamic range compression processing portion **377**.

$$R=\{F_{FRO}(BASE)-D_{min}\}/(Base-S_{min}) \tag{5}$$

In above Eq. (5), D_{min} indicates the minimum pixel density value after the dynamic range compression processing operation, which is a desired value arbitrarily determined, for example, in the range of "0.2" to "0.5".

As described above, the normal image density value conversion curve for the photographic image of the front of the chest preliminarily stored in the memory table in the pixel density value conversion curve defining portion **372** can be modified to obtain the pixel density value conversion curve $F_{FRO}(X)$ as indicated by the thick line in FIG. **27** which decreases at the slope of the compression factor (R) from the density reference value (BASE) toward the lower density on the pixel density conversion curve.

When the dynamic range compression processing operation as described hereinafter is carried out using the pixel density value conversion curve $F'_{FRO}(X)$ generated as

described above, it becomes possible to express pixels showing the minimum density value S_{min} in the subject area on the radiographic image, which were unable to be expressed in the case of the dynamic range compression processing being carried out using the normal pixel density value conversion curve, on a radiographic image after the dynamic range compression processing operation using the pixel density value conversion curve $F_{FRO}(X)$.

On the other hand, the image smoothing portion **370** moves the mask of the size having M pixels×M pixels (M is an arbitrary constant) on the radiographic, digital image $S_{org}(x,y)$ indicated by the radiographic, digital image data supplied from the image data storage. portion **311** and calculates an average of pixel values existing in the mask at each moving portion. Then the smoothing portion **370** replaces the pixel values used for the calculation of the average with the average obtained, thereby smoothing the radiographic, digital image, and generates data to indicate a radiographic, digital image $S_{US}(x,y)$ thus smoothed. Then the smoothing portion **370** outputs the data to indicate the smoothed radiographic, digital image $S_{US}(x,y)$ thus generated, to the subsequent high-frequency image generating portion **371**.

Then the high-frequency image generating portion **371** generates data indicating an image $S_{hp}(x,y)$ of high-frequency components in the radiographic, digital image $S_{org}(x,y)$ indicated by the radiographic, digital image data supplied from the image data storage portion **311**, according to Eq. (6) below, using the data indicating the radiographic, digital image $S_{org}(x,y)$, supplied from the image data storage portion **311**, and the data indicating the smoothed, radiographic, digital image $S_{US}(x,y)$, supplied from the image smoothing portion **370**.

$$S_{hp}(x,y)=S_{org}(x,y)-S_{US}(x,Y) \tag{6}$$

Then the dynamic range compression processing portion **377** converts the adjusted pixel density value conversion curve $F_{FRO}(X)$ indicated by the thin line in FIG. **27**, indicated by the data supplied from the pixel density value conversion curve defining portion **372**, to the image density value conversion curve $F_{FRO}(X)$ as indicated by the thick line in FIG. **27** in which the slope is decreased at the conversion factor (R) from the density reference value (BASE) to the lower density on the pixel density conversion curve, using the data indicating the density reference value (BASE), supplied from the density reference value defining portion **375**, and the data indicating the compression factor (R), supplied from the compression factor defining portion **376**. Further, the dynamic range compression processing portion **377** performs the dynamic range compression processing operation according to Eq. (7) below, using the data indicating the radiographic, digital image $S_{org}(x,y)$, supplied from the image data storage portion **311**, and the data indicating the image of high-frequency components $S_{hp}(x, y)$, supplied from the high-frequency image generating portion **371**.

$$S_{Drc}(x,y)=F_{FRO}(S_{org}(x,y))+[1-\{\partial F_{FRO}(S_{org}(x,y))\}/\{\partial S_{org}(x,y)\}]\times S_{hp}(x,y) \tag{7}$$

Namely, in accordance with above Eq. (7), the dynamic range compression processing portion **377** converts the pixel density values $S_{org}(x,y)$ of the radiographic, digital image supplied from the image data storage portion **311** to the pixel density values $F'_{FRO}(S_{org}(x,y))$ according to the pixel density value conversion curve $F_{FRO}(X)$, and further adds thereto the image pixel density values $S_{hp}(x,y)$ of the image of high-frequency components supplied from the high-frequency image generating portion **371** according to the slope of the pixel density value conversion curve $F'_{FRO}(X)$, thereby accomplishing the dynamic range compression processing operation. By carrying out this dynamic range compression processing, it becomes possible to arbitrarily set the dynamic range compression characteristics to compress the dynamic range of the radiographic, digital image while maintaining the information of high-frequency components in the radiographic, digital image, according to the photographing portion.

In the image processing portion **317**, when the side of the chest is discriminated as a photographing portion in the discriminating portion **313**, the pixel density value conversion curve defining portion **372** first selects the function data indicating the pixel density value conversion characteristics (curve) as indicated by the dashed line in FIG. **28**, according to the information representing the type of the radiographic device (i.e., the information indicating the radiographic, digital image taking device), outputted from the setting portion **312**, the information concerning the photographing portion (i.e., the information indicating the side of the chest), outputted from the discriminating portion **313**, and the information representing the type of the output device (i.e., the information indicating the film imager device), outputted from the output device selecting portion **314**, from the memory table preliminarily storing the function data to indicate the pixel density value conversion characteristics respectively corresponding to the types of radiographic devices, photographing portions, and types of output devices.

On the other hand, the pixel density value conversion curve defining portion **372** receives the data indicating the averages Cave, Rave, Lave, supplied from the characteristic amount calculating portion **316**. The defining portion **372** adjusts the pixel density value conversion curve by moving the curve in parallel in the direction indicated by the arrow in FIG. **28** up to the position indicated by the thin line in FIG. **28** so that the average Cave becomes the desired density value D_L of the pulmonary field preliminarily set, on the pixel density value conversion curve as indicated by the dashed line in FIG. **28**. Then the defining portion **372** outputs data indicating the pixel density value conversion curve $F_{LAT}((X)$ thus adjusted to the compression factor defining portion **376** and to the dynamic range compression processing means **377**.

The subject area defining section **373** separates the subject area, which is a transmitted image of the subject excluding the through area where radiations impinge directly on the sensor or the like without passing the subject, from the radiographic image indicated by the radiographic, digital image data supplied from the image data storage portion **311**, and then outputs information data representing the subject area thus separated to the subsequent subject area characteristic amount generating portion **374**.

Then the subject area characteristic amount generating portion **374** generates the maximum pixel density value S_{max} in the subject area, based on the information data representing the subject area supplied from the subject area defining portion **374**, and outputs data indicating the maximum pixel density value S_{max} thus generated as data indicating the characteristic amount of the subject area to the compression factor defining portion **376**.

The density reference value defining portion **375** receives the data representing the average Cave supplied from the characteristic amount calculating portion **316** and calculates the density reference value (BASE) according to Eq. (8)

below. The density reference value defining portion **375** then outputs data indicating the density reference value (BASE) thus calculated to the compression factor defining portion **376** and to the dynamic range compression processing portion **377**.

$$BASE=S_{max}+(S_{max}-Cave)\times\beta \quad (8)$$

In above Eq. (8) β is an arbitrary constant set according to the information concerning the type of the device outputting the radiographic, digital image data set in the setting portion.

Then the compression factor defining portion **376** receives the data indicating the adjusted pixel density value conversion curve $F_{LAT}(X)$ indicated by the thin line in FIG. **28**, supplied from the pixel density value conversion curve defining portion **372**, the data indicating the maximum pixel density value S_{max} as the characteristic amount of the subject area from the subject area characteristic amount generating portion **374**, and the data indicating the density reference value (BASE) from the density reference value defining portion **375**, and the compression factor defining portion **376** calculates the compression factor (R) according to Eq. (9) below, based on the data supplied from the respective portions. Then the compression factor defining portion **376** outputs data indicating the compression factor (R) thus calculated to the dynamic range compression processing portion **377**.

$$R=\{D_{max}-F_{LAT}(BASE)\}/(S_{max}-BASE) \quad (9)$$

In above Eq. (9), D_{max} indicates the maximum density value after the dynamic range compression processing operation, which is a desired value arbitrarily determined, for example, in the range of "2.7" to "3.0".

As described above, the normal pixel density value conversion curve for photography of the side of the chest, which is preliminarily stored in the memory table in the pixel density value conversion curve defining portion **372**, can be converted to the pixel density value conversion curve $F'_{LAT}(X)$ as indicated by the thick line in FIG. **28** in which the slope decreases at the compression factor (R) from the density reference value (BASE) toward the higher density on the pixel density conversion curve.

When the dynamic range compression processing operation described below is carried out using the pixel density value conversion curve $F'_{LAT}(X)$ generated as described above, it becomes possible to express pixels showing the maximum pixel density value S_{max} in the subject area on the radiographic image, which were unable to be expressed when the dynamic range compression processing operation was carried out using the normal pixel density value conversion curve, on a radiographic image after the dynamic range compression processing operation using the pixel density value conversion curve $F'_{LAT}(X)$.

After that, the dynamic range compression processing portion **377** carries out the like processing as in the case where the photographing portion is the front of the chest as described above, whereby it can compress the dynamic range of the radiographic, digital image according to the dynamic range compression characteristics arbitrarily set according to the photographing portion of the radiographic, digital image while maintaining the information of high-frequency components in the radiographic, digital image data supplied from the image data storage portion **311**.

As described above, the radiographic, digital image data resulting from the optimum dynamic range compression processing in the image processing portion **317** is supplied to the image output device **318**, and the image output device **318** prints the radiographic, digital image on the film with laser intensities corresponding to the pixel values indicated by the radiographic, digital image data supplied from the image processing portion **317**, whereby the radiographic, digital image can be formed in the compressed dynamic range according to the arbitrary dynamic range compression characteristics and in the optimum density on the film.

The operational example described above was explained as an example where the photographing portion was the "chest", but, for example in the case where the photographing portion is the "abdominal part", the system may be arranged so that the characteristic amount of image is computed from all the image areas corresponding to the positions of the photosensors indicated by **331**, **332**, **333** in FIG. **22** and the dynamic range compression processing is carried out based on the characteristic amount thus computed. In another case where the photographing portion is either of the "extremities", the system may be arranged so that the characteristic amount of image is computed from only the image area corresponding to the position of the photosensor indicated by **322** of FIG. **21** or by **333** of FIG. **22** and the dynamic range compression processing is carried out based on the characteristic amount thus computed. Further, in this case, the radiographic image taking device having the photosensors located at all the positions indicated by **331**, **332**, **333** of FIG. **22** does not have to be used, but the digital radiography can be performed by a radiographic image taking device having the photosensor located only at the position indicated by **333** of FIG. **22**, as shown in FIG. **22**.

As described above, the present embodiment can provide the radiographic, digital image processing system capable of automatically performing the optimum image processing for the radiographic, digital image without troubling the operator in such a manner that the same image processing effect can be achieved in the image area corresponding to the location of the photosensor on a variety of radiographic, digital images different in the photographing portion, in the physical constitution of the subject, and in the irradiation dose of radiations during radiography.

What is claimed is:

1. A radiographic, digital image processing system for processing a radiographic, digital image, comprising:

(A) photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity during radiography on a radiographic, digital image obtained by the radiography; and

(B) characteristic amount generating means for generating a characteristic amount of the image area corresponding to the location of the photosensor on the radiographic, digital image defined by said photosensor area defining means.

2. A radiographic, digital image processing system according to claim **1**, wherein said characteristic amount is either one selected from a maximum, a minimum, and an average of pixel values in the image area.

3. A radiographic, digital image processing system according to claim **1**, said radiographic, digital image processing system further comprising input means for inputting radiographic, digital image data digitized from the image obtained by the radiography.

4. A radiographic, digital image processing system according to claim **3**, said radiographic, digital image processing system further comprising storage means for storing the radiographic, digital image data inputted by said input means.

5. A radiographic, digital image processing system according to claim 3, said radiographic, digital image processing system further comprising image processing means for effecting image processing on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the characteristic amount generated in said characteristic amount generating means.

6. A radiographic, digital image processing system according to claim 5, said radiographic, digital image processing system further comprising image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

7. A radiographic, digital image processing system according to claim 6, said radiographic, digital image processing system further comprising output device selecting means for selecting a type of an output device of said radiographic, digital image.

8. A radiographic, digital image processing system according to claim 7, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to types of output devices and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table, according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, and to effect density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

9. A radiographic, digital image processing system according to claim 7, wherein said image processing means is arranged to effect the image processing to control a dynamic range of the radiographic, digital image, according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means and the information concerning the characteristic amount generated in said characteristic amount generating means, on the radiographic, digital image data inputted by said input means.

10. A radiographic, digital image processing system according to claim 7, wherein said image processing means comprises a look-up table storing data indicating pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding pixel density value conversion curve from said look-up table, according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, and to effect the image processing to control a dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the data indicating the pixel density value conversion curve thus read.

11. A radiographic, digital image processing system according to claim 7, wherein said image processing means comprises a look-up table storing data indicating standard pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding standard pixel density value conversion curve from said look-up table, according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, to adjust the standard pixel density value conversion curve indicated by the data thus read, according to the information concerning the photographing portion selected by said output device selecting means and the information concerning the characteristic amount generated in said characteristic amount generating means, and to effect the image processing to control a dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the pixel density value conversion curve thus adjusted.

12. A radiographic, digital image processing system according to claim 5, wherein said image processing means is arranged to set, according to the information concerning the characteristic amount generated in said characteristic amount generating means, a value at a predetermined position on a pixel density value conversion curve used in effecting the image processing to carry out density and/or gradation conversion processing of the radiographic, digital image indicated by the radiographic, digital image data, on the radiographic, digital image data inputted by said input means.

13. A radiographic, digital image processing system according to claim 5, wherein said image processing means is arranged to set, according to the information concerning the characteristic amount generated in said characteristic amount generating means, a value at a change point on a pixel density value conversion curve used in effecting the image processing to compress a dynamic range of the radiographic, digital image indicated by the radiographic, digital image data, on the radiographic, digital image data inputted by said input means.

14. A radiographic, digital image processing system according to claim 5, wherein said image processing means is arranged to set, according to the information concerning the characteristic amount generated in said characteristic amount generating means, a slope around a change point on a pixel density value conversion curve used in effecting the image processing to compress a dynamic range of the radiographic, digital image indicated by the radiographic, digital image data, on the radiographic, digital image data inputted by said input means.

15. A radiographic, digital image processing system according to claim 5, said radiographic, digital image processing system further comprising setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means.

16. A radiographic, digital image processing system according to claim 15, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to the information concerning the type of the generating source set by said setting means and to effect density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

17. A radiographic, digital image processing system according to claim 15, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to kinds of photographing portions and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to the

information concerning a kind of a photographing portion discriminated by discriminating means and to effect density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

18. A radiographic, digital image processing system according to claim 15, wherein said image processing means is arranged to effect the image processing to control a dynamic range of the radiographic, digital image according to information concerning the type of the generating source set by said setting means and the information concerning the characteristic amount generated in said characteristic amount generating means, on the radiographic, digital image data inputted by said input means.

19. A radiographic, digital image processing system according to claim 15, wherein said image processing means comprises a look-up table storing data indicating pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding pixel density value conversion curve from said look-up table, according to the information concerning the type of the generating source set by said setting means, and to effect the image processing to control a dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the data indicating the pixel density value conversion curve thus read.

20. A radiographic, digital image processing system according to claim 15, wherein said image processing means comprises a look-up table storing data indicating standard pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding standard pixel density value conversion curve from said look-up table, according to information concerning the type of the generating source set by said setting means, to adjust the standard pixel density value conversion curve indicated by the data thus read, according to the information concerning the type of the generating source set by said setting means and the information concerning the characteristic amount generated in said characteristic amount generating means, and to effect the image processing to control a dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the pixel density value conversion curve thus adjusted.

21. A radiographic, digital image processing system according to claim 5, said radiographic, digital image processing system further comprising discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means.

22. A radiographic, digital image processing system according to claim 21, wherein said image processing means is arranged to effect the image processing to carry out density and/or gradation conversion processing of the radiographic, digital image according to information concerning the photographing portion discriminated by said discriminating means and the information concerning the characteristic amount generated in said characteristic amount generating means, on the radiographic, digital image data inputted by said input means.

23. A radiographic, digital image processing system according to claim 21, wherein said image processing means

is arranged to effect the image processing to control a dynamic range of the radiographic, digital image according to information 1concerning the photographing portion discriminated by said discriminating means and the information concerning the characteristic amount generated in said characteristic amount generating means, on the radiographic, digital image data inputted by said input means.

24. A radiographic, digital image processing system according to claim 21, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to kinds of photographing portions and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to the information concerning a kind of the photographing portion discriminated by said discriminating means and to effect density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

25. A radiographic, digital image processing system according to claim 21, wherein said image processing means comprises a look-up table storing data indicating pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding pixel density value conversion curve from said look-up table, according to information concerning the photographing portion discriminated by said discriminating means, and to effect the image processing to control a dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the data indicating the pixel density value conversion curve thus read.

26. A radiographic, digital image processing system according to claim 21, wherein said image processing means comprises a look-up table storing data indicating standard pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding standard pixel density value conversion curve from said look-up table, according to information concerning the photographing portion discriminated by said discriminating means, to adjust the standard pixel density value conversion curve indicated by the data thus read, according to the information concerning the photographing portion discriminated by said discriminating means and the information concerning the characteristic amount generated in said characteristic amount generating means, and to effect the image processing to control a dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the pixel density value conversion curve thus adjusted.

27. A radiographic, digital image processing system according to claim 3, said radiographic, digital image processing system further comprising setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means.

28. A radiographic, digital image processing system according to claim 27, wherein said setting means is arranged to automatically set the type of the generating source, according to the information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

29. A radiographic, digital image processing system according to claim 27, wherein said photosensor area defin-

ing means is arranged to define the image area corresponding to the location of the photosensor for detecting intensity of radiations during the radiography on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means according to information concerning the type of the generating source set by said setting means.

30. A radiographic, digital image processing system according to claim 3, said radiographic, digital image processing system further comprising discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means.

31. A radiographic, digital image processing system according to claim 30, wherein said discriminating means is arranged to automatically discriminate the photographing portion, according to information concerning the photographing portion accompanying the radiographic, digital image data inputted by said input means.

32. A radiographic, digital image processing system according to claim 30, wherein said photosensor area defining means is arranged to define the image area corresponding to the location of the photosensor for detecting the intensity of radiations during the radiography on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the photographing portion of the radiographic, digital image discriminated by said discriminating means.

33. A radiographic, digital image processing system according to claim 3, said radiographic, digital image processing system further comprising output device selecting means for selecting a type of an output device of said radiographic, digital image.

34. A radiographic, digital image processing system according to claim 33, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to a type of a generating source, according to a type of a generating source of the radiographic, digital image data inputted by said input means.

35. A radiographic, digital image processing system according to claim 33, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to a type of a generating source, according to information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

36. A radiographic, digital image processing system for processing a radiographic, digital image, comprising:

(A) input means for inputting radiographic, digital image data digitized from an image obtained by radiography;

(B) setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means;

(C) photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity of radiations during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the type of the generating source set by said setting means;

(D) characteristic amount calculating means for calculating a characteristic amount of the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means;

(E) discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means;

(F) output device selecting means for selecting a type of an output device of the radiographic, digital image;

(G) image processing means for effecting density and/or gradation conversion processing according to the information concerning the type of the generating source set by said setting means, information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, information concerning the photographing portion discriminated by said discriminating means, and information concerning the characteristic amount calculated by said characteristic amount calculating means; and

(H) image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

37. A radiographic, digital image processing system according to claim 36, wherein said setting means is arranged to automatically set the type of the generating source, according to the information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

38. A radiographic, digital image processing system according to claim 36, wherein said discriminating means is arranged to automatically discriminate the photographing portion, according to the information concerning the photographing portion accompanying the radiographic, digital image data inputted by said input means.

39. A radiographic, digital image processing system according to claim 36, wherein said photosensor area defining means is arranged to automatically define the image area corresponding to the location of the photosensor on the radiographic, digital image, according to the information concerning the type of the generating source set by said setting means.

40. A radiographic, digital image processing system according to claim 36, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to the information concerning the type of the generating source set by said setting means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

41. A radiographic, digital image processing system according to claim 36, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to kinds of photographing portions and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to information concerning a kind of the photographing portion discriminated by said discriminating means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

42. A radiographic, digital image processing system according to claim 36, wherein said image processing means comprises a look-up table storing data indicating density

conversion curves in correspondence to types of output devices and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table, according to the information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

43. A radiographic, digital image processing system according to claim 36, said radiographic, digital image processing system further comprising storage means for storing the radiographic, digital image data inputted by said input means.

44. A radiographic, digital image processing system according to claim 36, wherein said characteristic amount is either one selected from a maximum, a minimum, an average, a median, and a mode.

45. A radiographic, digital image processing system according to claim 36, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to the type of the generating source, according to the information concerning the type of the generating source set by said setting means.

46. A radiographic, digital image processing system according to claim 36, wherein said photosensor area defining means is arranged to automatically define the image area corresponding to the location of the photosensor on the radiographic, digital image, according to the information concerning the photographing portion discriminated by said discriminating means.

47. A radiographic, digital image processing system for processing a radiographic, digital image, comprising:

(A) input means for inputting radiographic, digital image data digitized from an image obtained by radiography;

(B) setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means;

(C) photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity of radiations during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the type of the generating source set by said setting means;

(D) subject area extracting means for, extracting an image area of a subject on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means and outputting information concerning the image area of the subject;

(E) photosensor area correcting means for correcting the image area corresponding to the location of the photosensor on the radiographic, digital image defined by said photosensor area defining means, according to the information concerning the image area of the subject outputted from said subject area extracting means;

(F) characteristic amount calculating means for calculating a characteristic amount of the image area corrected by said photosensor area correcting means;

(G) discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means;

(H) output device selecting means for selecting a type of an output device of the radiographic, digital image;

(I) image processing means for effecting density and/or gradation conversion processing according to the information concerning the type of the generating source set by said setting means, information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, information concerning the photographing portion discriminated by said discriminating means, and information concerning the characteristic amount calculated by said characteristic amount calculating means; and

(J) image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

48. A radiographic, digital image processing system according to claim 47, wherein said setting means is arranged to automatically set the type of the generating source, according to the information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

49. A radiographic, digital image processing system according to claim 47, wherein said discriminating means is arranged to automatically discriminate the photographing portion, according to the information concerning the photographing portion accompanying the radiographic, digital image data inputted by said input means.

50. A radiographic, digital image processing system according to claim 47, wherein said photosensor area defining means is arranged to automatically define the image area corresponding to the location of the photosensor on the radiographic, digital image, according to the information concerning the type of the generating source set by said setting means.

51. A radiographic, digital image processing system according to claim 47, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to the information concerning the type of the generating source set by said setting means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

52. A radiographic, digital image processing system according to claim 47, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to kinds of photographing portions and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to information concerning a kind of the photographing portion discriminated by said discriminating means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

53. A radiographic, digital image processing system according to claim 47, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to types of output devices and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table, according to the information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means,

and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

54. A radiographic, digital image processing system according to claim 47, said radiographic, digital image processing system further comprising storage means for storing the radiographic, digital image data inputted by said input means.

55. A radiographic, digital image processing system according to claim 47, wherein said characteristic amount is either one selected from a maximum, a minimum, an average, a median, and a mode.

56. A radiographic, digital image processing system according to claim 47, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to the type of the generating source, according to the information concerning the type of the generating source set by said setting means.

57. A radiographic, digital image processing system according to claim 47, wherein said photosensor area defining means is arranged to automatically define the image area corresponding to the location of the photosensor on the radiographic, digital image, according to the information concerning the photographing portion discriminated by said discriminating means.

58. A radiographic, digital image processing system according to claim 47, wherein said subject area extracting means is arranged to extract the image area of the subject on the radiographic, digital image, according to a histogram of pixel values of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means.

59. A radiographic, digital image processing system according to claim 47, wherein said subject area extracting means is arranged to extract the image area of the subject on the radiographic, digital image, according to a profile of pixel values of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means.

60. A radiographic, digital image processing system according to claim 47, wherein said photosensor area correcting means is arranged to output, as information concerning a corrected image area, information concerning an overlapping image area between the image area corresponding to the location of the photosensor on the radiographic, digital image defined by said photosensor area defining means and the image area of the subject indicated by the information data outputted from said subject area extracting means.

61. A radiographic, digital image processing system for processing a radiographic, digital image, comprising:

(A) input means for inputting radiographic, digital image data digitized from an image obtained by radiography;

(B) setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means;

(C) photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity of radiations during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the type of the generating source set by said setting means;

(D) characteristic amount calculating means for calculating a characteristic amount of the image area corresponding to the location of the photosensor on the radiographic, digital image, according to a histogram of pixel values in the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means;

(E) image processing means for effecting density and/or gradation conversion processing according to the information concerning the type of the generating source set by said setting means and information concerning the characteristic amount calculated by said characteristic amount calculating means; and

(F) image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

62. A radiographic, digital image processing system according to claim 61, wherein said setting means is arranged to automatically set the type of the generating source, according to the information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

63. A radiographic, digital image processing system according to claim 61, wherein said photosensor area defining means is arranged to automatically define the image area corresponding to the location of the photosensor on the radiographic, digital image, according to the information concerning the type of the generating source set by said setting means.

64. A radiographic, digital image processing system according to claim 61, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to the information concerning the type of the generating source set by said setting means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

65. A radiographic, digital image processing system according to claim 61, wherein said characteristic amount calculating means is arranged to extract a predetermined image area on the radiographic, digital image, according to a histogram of pixel values in the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means, and to calculate the characteristic amount in the predetermined image area on the radiographic, digital image thus extracted.

66. A radiographic, digital image processing system according to claim 61, wherein said characteristic amount calculating means is arranged to extract an image area excluding an image area corresponding to an auxiliary device on the radiographic, digital image, according to a histogram of pixel values in the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means, and to calculate the characteristic amount in the predetermined image area on the radiographic, digital image thus extracted.

67. A radiographic, digital image processing system according to claim 61, wherein said characteristic amount is either one selected from a maximum, a minimum, an average, a median, and a mode.

68. A radiographic, digital image processing system according to claim 61, said radiographic, digital image processing system further comprising storage means for storing the radiographic, digital image data inputted by said input means.

69. A radiographic, digital image processing system according to claim 61, said radiographic, digital image processing system further comprising discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means.

70. A radiographic, digital image processing system according to claim 69, wherein said discriminating means is arranged to automatically discriminate the photographing portion, according to the information concerning the photographing portion accompanying the radiographic, digital image data inputted by said input means.

71. A radiographic, digital image processing system according to claim 69, wherein said photosensor area defining means is arranged to automatically define the image area corresponding to the location of the photosensor on the radiographic, digital image, according to the information concerning the photographing portion discriminated by said discriminating means.

72. A radiographic, digital image processing system according to claim 69, wherein said image processing means includes a look-up table storing data indicating density conversion curves in correspondence to kinds of photographing portions and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to information concerning a kind of the photographing portion discriminated by said discriminating means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

73. A radiographic, digital image processing system according to claim 61, said radiographic, digital image processing system further comprising output device selecting means for selecting a type of an output device of said radiographic, digital image.

74. A radiographic, digital image processing system according to claim 73, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to the type of the generating source, according to the information concerning the type of the generating source set by said setting means.

75. A radiographic, digital image processing system according to claim 73, wherein said image processing means includes a look-up table storing data indicating density conversion curves in correspondence to types of output devices and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

76. A radiographic, digital image processing system for processing a radiographic, digital image, comprising:

(A) input means for inputting radiographic, digital image data digitized from an image obtained by radiography;

(B) photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity of radiations during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means;

(C) characteristic amount calculating means for calculating a characteristic amount of the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means;

(D) image processing means for effecting density and/or gradation conversion processing according to information concerning the characteristic amount calculated by said characteristic amount calculating means, on the radiographic, digital image data inputted by said input means; and

(E) image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

77. A radiographic, digital image processing system according to claim 76, said radiographic, digital image processing system further comprising storage means for storing the radiographic, digital image data inputted by said input means.

78. A radiographic, digital image processing system according to claim 76, wherein said characteristic amount is either one selected from a maximum, a minimum, an average, a median, and a mode.

79. A radiographic, digital image processing system according to claim 76, said radiographic, digital image processing system further comprising setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means.

80. A radiographic, digital image processing system according to claim 79, wherein said setting means is arranged to automatically set the type of the generating source, according to the information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

81. A radiographic, digital image processing system according to claim 79, wherein said photosensor area defining means is arranged to define the image area corresponding to the location of the photosensor for detecting the intensity of radiations during the radiography on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the type of the generating source set by said setting means.

82. A radiographic, digital image processing system according to claim 79, wherein said photosensor area defining means is arranged to automatically define the image area corresponding to the location of the photosensor on the radiographic, digital image, according to information concerning the type of the generating source set by said setting means.

83. A radiographic, digital image processing system according to claim 79, wherein said image processing means is arranged to effect the density and/or gradation conversion processing according to information concerning the type of the generating source set by said setting means and the information concerning the characteristic amount calculated by said characteristic amount calculating means, on the radiographic, digital image data inputted by said input means.

84. A radiographic, digital image processing system according to claim 79, wherein said image processing means includes a look-up table storing data indicating density conversion curves in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to information concerning

the type of the generating source set by said setting means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

85. A radiographic, digital image processing system according to claim 76, said radiographic, digital image processing system further comprising discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means.

86. A radiographic, digital image processing system according to claim 85, wherein said discriminating means is arranged to automatically discriminate the photographing portion, according to the information concerning the photographing portion accompanying the radiographic, digital image data inputted by said input means.

87. A radiographic, digital image processing system according to claim 85, wherein said photosensor area defining means is arranged to define the image area corresponding to the location of the photosensor for detecting the intensity of radiations during the radiography on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the photographing portion discriminated by said discriminating means.

88. A radiographic, digital image processing system according to claim 85, wherein said photosensor area defining means is arranged to automatically define the image area corresponding to the location of the photosensor on the radiographic, digital image, according to information concerning the photographing portion discriminated by said discriminating means.

89. A radiographic, digital image processing system according to claim 85, wherein said image processing means is arranged to effect the density and/or gradation conversion processing according to information concerning the photographing portion discriminated by said discriminating means and the information concerning the characteristic amount calculated by said characteristic amount calculating means, on the radiographic, digital image data inputted by said input means.

90. A radiographic, digital image processing system according to claim 85, wherein said image processing means includes a look-up table storing data indicating density conversion curves in correspondence to kinds of photographing portions and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to the information concerning a kind of the photographing portion discriminated by said discriminating means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

91. A radiographic, digital image processing system according to claim 76, said radiographic, digital image processing system further comprising output device selecting means for selecting a type of an output device of said radiographic, digital image.

92. A radiographic, digital image processing system according to claim 91, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to the type of the generating source, according to the type of the generating source of the radiographic, digital image data inputted by said input means.

93. A radiographic, digital image processing system according to claim 91, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to the type of the generating source, according to information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

94. A radiographic, digital image processing system according to claim 91, wherein said image processing means is arranged to effect the density and/or gradation conversion processing according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means and the information concerning the characteristic amount calculated by said characteristic amount calculating means, on the radiographic, digital image data inputted by said input means.

95. A radiographic, digital image processing system according to claim 91, wherein said image processing means includes a look-up table storing data indicating density conversion curves in correspondence to types of output devices and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means and to effect the density and/or gradation conversion processing on the radiographic, digital image data inputted by said input means, using the data indicating the density conversion curve thus read.

96. A radiographic, digital image processing system for processing a radiographic, digital image, comprising:

(A) detecting means disposed at a predetermined location for detecting intensity of radiations at a subject during radiography;

(B) input means for inputting image data obtained by said radiography;

(C) area defining means for defining an image area corresponding to the location of said detecting means on an image of the image data inputted by said input means;

(D) weighting means for calculating a value of each pixel value of the image area defined by said area defining means, multiplied by a predetermined weighting factor; and

(E) image processing means for effecting density and/or gradation conversion processing according to the weighted value by said weighting means, on the image data inputted by said input means.

97. A radiographic, digital image processing system according to claim 96, said radiographic, digital image processing system further comprising image output means for outputting image data resulting from the image processing by said image processing means.

98. A radiographic, digital image processing system according to claim 96, wherein said weighting means is arranged to vary said weighting factors from a center line to a peripheral part of a detection area of said detecting means.

99. A radiographic, digital image processing system according to claim 96, wherein said weighting means is arranged to vary said weighting factors from a center point to a peripheral part of a detection area of said detecting means.

100. A radiographic, digital image processing system according to claim 96, said radiographic, digital image

processing system further comprising storage means for storing the image data inputted by said input means.

101. A radiographic, digital image processing system according to claim **96**, said radiographic, digital image processing system further comprising setting means for setting a type of a generating source of the image data inputted by said input means.

102. A radiographic, digital image processing system according to claim **101**, wherein said setting means is arranged to automatically set the type of the generating source, based on information concerning the type of the generating source accompanying the image data inputted by said input means.

103. A radiographic, digital image processing system according to claim **101**, wherein said area defining means is arranged to define the image area corresponding to the location of said detecting means indicated by the image data inputted by said input means, based on information concerning the type of the generating source set by said setting means.

104. A radiographic, digital image processing system according to claim **101**, wherein said area defining means is arranged to automatically define the image area corresponding to the location of said detecting means, based on information concerning the type of the generating source set by said setting means.

105. A radiographic, digital image processing system according to claim **101**, wherein said image processing means is arranged to effect the density and/or gradation conversion processing according to information concerning the type of the generating source set by said setting means and said weighted value, on the image data inputted by said input means.

106. A radiographic, digital image processing system according to claim **101**, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table, based on information concerning the type of the generating source set by said setting means, and to effect the density and/or gradation conversion processing on the image data inputted by said input means, using the data indicating the density conversion curve thus read.

107. A radiographic, digital image processing system according to claim **96**, said radiographic, digital image processing system further comprising discriminating means for discriminating a photographing portion of the image indicated by the image data inputted by said input means.

108. A radiographic, digital image processing system according to claim **107**, wherein said discriminating means is arranged to automatically discriminate the photographing portion, based on information concerning the photographing portion accompanying the radiographic, digital image data inputted by said input means.

109. A radiographic, digital image processing system according to claim **107**, wherein said area defining means is arranged to define the image area corresponding to the location of said detecting means indicated by the image data inputted by said input means, based on information concerning the photographing portion of the image discriminated by said discriminating means.

110. A radiographic, digital image processing system according to claim **107**, wherein said area defining means is arranged to automatically define the image area corresponding to the location of said detecting means indicated by the image data inputted by said input means, based on information concerning the photographing portion accompanying the image data inputted by said input means.

111. A radiographic, digital image processing system according to claim **107**, wherein said image processing means is arranged to effect the density and/or gradation conversion processing according to information concerning the photographing portion discriminated by said discriminating means and said weighted value, on the image data inputted by said input means.

112. A radiographic, digital image processing system according to claim **107**, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to kinds of photographing portions and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table, based on information concerning the photographing portion discriminated by said discriminating means, and to effect the density and/or gradation conversion processing on the image data inputted by said input means, using the data indicating the density conversion curve thus read.

113. A radiographic, digital image processing system according to claim **107**, said radiographic, digital image processing system further comprising selecting means for selecting a type of an image output device for visualizing the image data outputted from said image output means to output a visualized image.

114. A radiographic, digital image processing system according to claim **113**, wherein said selecting means is arranged to automatically select the image output device preliminarily set corresponding to the type of the generating source, based on the type of the generating source of the image data inputted by said input means.

115. A radiographic, digital image processing system according to claim **113**, wherein said selecting means is arranged to automatically select the image output device preliminarily set corresponding to the type of the generating source, based on information concerning the type of the generating source accompanying the image data inputted by said input means.

116. A radiographic, digital image processing system according to claim **113**, wherein said image processing means is arranged to effect the density and/or gradation conversion processing according to information concerning the type of the image output device selected by said selecting means and the value calculated by said weighting means, on the image data inputted by said input means.

117. A radiographic, digital image processing system according to claim **113**, wherein said image processing means comprises a look-up table storing data indicating density conversion curves in correspondence to types of output devices and said image processing means is arranged to read data indicating a corresponding density conversion curve from said look-up table, according to information concerning the type of the image output device selected by said selecting means, and to effect the density and/or gradation conversion processing on the image data inputted by said input means, using the data indicating the density conversion curve thus read.

118. A radiographic, digital image processing method for processing a radiographic, digital image, comprising the following steps:

(A) a step of detecting intensity of radiations at a subject during radiography, using detecting means disposed at a predetermined location;

(B) a step of inputting image data obtained by said radiography;

(C) a step of defining an image area corresponding to the location of said detecting means on an image of the image data inputted in said inputting step;

(D) a step of calculating a value of a pixel value of the image area defined in said area defining step, multiplied by a predetermined weighting factor; and

(E) a step of effecting density and/or gradation conversion processing according to the weighted value in said weighting step, on the image data inputted in said inputting step.

119. A storage medium capable of being read by a computer storing a program for carrying out radiographic, digital image processing for processing a radiographic, digital image, said storage medium comprising a program for carrying out the following processes:

(A) a process of detecting intensity of radiations at a subject during radiography using detecting means disposed at a predetermined location;

(B) a process of inputting image data obtained by said radiography;

(C) a process of defining an image area corresponding to the location of said detecting means on an image of the image data inputted in said inputting process;

(D) a process of calculating a value of a pixel value of the image area defined in said area defining process, multiplied by a predetermined weighting factor; and

(E) a process of effecting density and/or gradation conversion processing according to the weighted value in said weighting process, on the image data inputted in said inputting process.

120. A radiographic, digital image processing system for processing a radiographic, digital image, comprising:

(A) input means for inputting radiographic, digital image data digitized from an image obtained by radiography;

(B) photosensor area defining means for defining an image area corresponding to a location of a photosensor for detecting intensity during the radiography on a radiographic, digital image indicated by the radiographic, digital image data inputted by said input means;

(C) characteristic amount generating means for generating a characteristic amount of the image area corresponding to the location of the photosensor on the radiographic, digital image, defined by said photosensor area defining means;

(D) image processing means for effecting image processing to control a dynamic range of the radiographic, digital image indicated by the radiographic, digital image data, on the radiographic, digital image data inputted by said input means, according to information concerning the characteristic amount generated by said characteristic amount generating means; and

(E) image output means for outputting a visualized, radiographic, digital image corresponding to radiographic, digital image data resulting from the image processing in said image processing means.

121. A radiographic, digital image processing system according to claim **120**, said radiographic, digital image processing system further comprising storage means for storing the radiographic, digital image data inputted by said input means.

122. A radiographic, digital image processing system according to claim **120**, wherein said characteristic amount is either one selected from a maximum, a minimum, and an average of pixel values in the image area.

123. A radiographic, digital image processing system according to claim **120**, wherein said image processing means is arranged to set, according to the information concerning the characteristic amount generated in said characteristic amount generating means, a value at a change point on a pixel density value conversion curve used in effecting the image processing to compress the dynamic range of the radiographic, digital image indicated by the radiographic, digital image data, on the radiographic, digital image data inputted by said input means.

124. A radiographic, digital image processing system according to claim **120**, wherein said image processing means is arranged to set, according to the information concerning the characteristic amount generated in said characteristic amount generating means, a slope around a change point on a pixel density value conversion curve used in effecting the image processing to compress the dynamic range of the radiographic, digital image indicated by the radiographic, digital image data, on the radiographic, digital image data inputted by said input means.

125. A radiographic, digital image processing system according to claim **120**, said radiographic, digital image processing system further comprising setting means for setting a type of a generating source of the radiographic, digital image data inputted by said input means.

126. A radiographic, digital image processing system according to claim **125**, wherein said setting means is arranged to automatically set the type of the generating source, according to information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

127. A radiographic, digital image processing system according to claim **125**, wherein said photosensor area defining means is arranged to define the image area corresponding to the location of the photosensor for detecting the intensity of radiations during the radiography on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the type of the generating source set by said setting means.

128. A radiographic, digital image processing system according to claim **125**, wherein said image processing means is arranged to effect the image processing to control the dynamic range of the radiographic, digital image according to information concerning the type of the generating source set by said setting means and the information concerning the characteristic amount generated in said characteristic amount generating means, on the radiographic, digital image data inputted by said input means.

129. A radiographic, digital image processing system according to claim **125**, wherein said image processing means comprises a look-up table storing data indicating pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding pixel density value conversion curve from said look-up table, according to information concerning the type of the generating source set by said setting means, and to effect the image processing to control the dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the data indicating the pixel density value conversion curve thus read.

130. A radiographic, digital image processing system according to claim **125**, wherein said image processing means comprises a look-up table storing data indicating

standard pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding standard pixel density value conversion curve from said look-up table, according to information concerning the type of the generating source set by said setting means, to adjust the standard pixel density value conversion curve indicated by the data thus read, according to the information concerning the type of the generating source set by said setting means and the information concerning the characteristic amount generated in said characteristic amount generating means, and to effect the image processing to control the dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the pixel density value conversion curve thus adjusted.

131. A radiographic, digital image processing system according to claim **120**, said radiographic, digital image processing system further comprising discriminating means for discriminating a photographing portion of the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means.

132. A radiographic, digital image processing system according to claim **131**, wherein said discriminating means is arranged to automatically discriminate the photographing portion, according to information concerning the photographing portion accompanying the radiographic, digital image data inputted by said input means.

133. A radiographic, digital image processing system according to claim **131**, wherein said photosensor area defining means is arranged to define the image area corresponding to the location of the photosensor for detecting the intensity of radiations during the radiography on the radiographic, digital image indicated by the radiographic, digital image data inputted by said input means, according to information concerning the photographing portion of the radiographic, digital image discriminated by said discriminating means.

134. A radiographic, digital image processing system according to claim **131**, wherein said image processing means is arranged to effect the image processing to control the dynamic range of the radiographic, digital image according to information concerning the photographing portion discriminated by said discriminating means and the information concerning the characteristic amount generated in said characteristic amount generating means, on the radiographic, digital image data inputted by said input means.

135. A radiographic, digital image processing system according to claim **131**, wherein said image processing means comprises a look-up table storing data indicating pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding pixel density value conversion curve from said look-up table, according to information concerning the photographing portion discriminated by said discriminating means, and to effect the image processing to control the dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the data indicating the pixel density value conversion curve thus read.

136. A radiographic, digital image processing system according to claim **131**, wherein said image processing means comprises a look-up table storing data indicating standard pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding standard pixel density value conversion curve from said look-up table, according to information concerning the photographing portion discriminated by said discriminating means, to adjust the standard pixel density value conversion curve indicated by the data thus read, according to the information concerning the photographing portion discriminated by said discriminating means and the information concerning the characteristic amount generated in said characteristic amount generating means, and to effect the image processing to control the dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the pixel density value conversion curve thus adjusted.

137. A radiographic, digital image processing system according to claim **120**, said radiographic, digital image processing system further comprising output device selecting means for selecting a type of an output device of said radiographic, digital image.

138. A radiographic, digital image processing system according to claim **137**, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to the type of the generating source, according to the type of the generating source of the radiographic, digital image data inputted by said input means.

139. A radiographic, digital image processing system according to claim **137**, wherein said output device selecting means is arranged to automatically select the output device of the radiographic, digital image preliminarily set corresponding to the type of the generating source, according to information concerning the type of the generating source accompanying the radiographic, digital image data inputted by said input means.

140. A radiographic, digital image processing system according to claim **137**, wherein said image processing means is arranged to effect the image processing to control the dynamic range of the radiographic, digital image according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means and the information concerning the characteristic amount generated in said characteristic amount generating means, on the radiographic, digital image data inputted by said input means.

141. A radiographic, digital image processing system according to claim **137**, wherein said image processing means comprises a look-up table storing data indicating pixel density value conversion curves for conversion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding pixel density value conversion curve from said look-up table, according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, and to effect the image processing to control the dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the data indicating the pixel density value conversion curve thus read.

142. A radiographic, digital image processing system according to claim **137**, wherein said image processing means comprises a look-up table storing data indicating standard pixel density value conversion curves for conver-

sion of pixel density values of a radiographic, digital image in correspondence to types of generating sources and said image processing means is arranged to read data indicating a corresponding standard pixel density value conversion curve from said look-up table, according to information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means, to adjust the standard pixel density value conversion curve indicated by the data thus read, according to the information concerning the type of the output device of the radiographic, digital image selected by said output device selecting means and the information concerning the characteristic amount generated in said characteristic amount generating means, and to effect the image processing to control the dynamic range of the radiographic, digital image, on the radiographic, digital image data inputted by said input means, using the pixel density value conversion curve thus adjusted.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,314,198 B1
DATED : November 6, 2001
INVENTOR(S) : Takashi Ogura

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [30], **Foreign Application Priority Data,** "Sep. 25, 1996 (JP)... 10-271576" should read -- Sep. 25, 1998 (JP)... 10-271576 --

Column 2,
Line 19, "described itu above" should read -- described above --

Column 6,
Line 35, "Illustrated" should read -- illustrated --

Column 36,
Line 30, "Eq. (4) a" should read -- Eq. (4) α --

Column 37,
Line 13, "storage. portion" should read -- storage portion --
Line 35, equation (6), "$S_{hp}(x,y)=S_{org}(x,y)-S_{US}(x,Y)$" should read -- $S_{hp}(x,y)=S_{org}(x,y)-S_{US}(x,y)$ --

Column 44,
Line 3, "information 1concerning" should read -- information concerning --

Column 47,
Line 47, "for, extracting" should read -- for extracting --

Signed and Sealed this

Twenty-seventh Day of August, 2002

Attest:

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

Attesting Officer

US005937087A

United States Patent [19]

Sasanuma et al.

[11] **Patent Number: 5,937,087**

[45] **Date of Patent: *Aug. 10, 1999**

[54] **IMAGE PROCESSING APPARATUS AND METHOD THEREOF**

[75] Inventors: **Nobuatsu Sasanuma**, Yokohama; **Tatsuo Takeuchi**, Kawasaki; **Rie Saito**, Yokohama; **Yuichi Ikeda**, Tokyo, all of Japan

[73] Assignee: **Canon Kabushiki Kaisha**, Tokyo, Japan

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

[21] Appl. No.: **08/508,259**

[22] Filed: **Jul. 27, 1995**

[30] **Foreign Application Priority Data**

Jul. 29, 1994 [JP] Japan 6-178127

[51] **Int. Cl.**^{6} **H04N 1/46**; G03F 3/08

[52] **U.S. Cl.** **382/167**; 358/506; 358/518; 358/529

[58] **Field of Search** 358/529, 500, 358/501, 506, 518, 521, 296, 487; 382/162, 167

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,481,542	11/1984	Goldberg	358/331
4,551,751	11/1985	Jung	358/75
4,642,681	2/1987	Ikeda	358/79
4,734,762	3/1988	Aoki et al.	358/80
4,847,654	7/1989	Honma et al.	358/300
4,873,570	10/1989	Suzuki et al.	358/80
4,982,277	1/1991	Katoh et al.	358/80
5,084,758	1/1992	Danzuka et al.	358/296
5,138,443	8/1992	Ikeda et al.	358/80
5,194,945	3/1993	Kadowaki et al.	358/75
5,267,031	11/1993	Kotoh et al.	358/527
5,331,440	7/1994	Kita et al.	358/529
5,383,055	1/1995	Sasanuma et al.	358/521
5,386,305	1/1995	Usami	358/518
5,557,428	9/1996	Watanabe	358/501
5,563,725	10/1996	Kumada et al.	358/518

FOREIGN PATENT DOCUMENTS

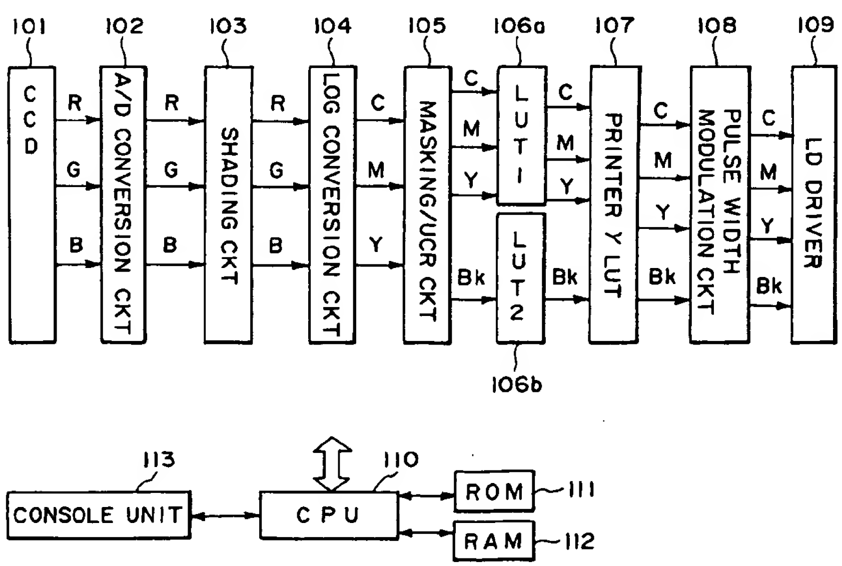
0091501	10/1983	European Pat. Off. .
0267566	5/1988	European Pat. Off. .
2050751	1/1981	United Kingdom .

Primary Examiner—Kim Yen Vu
Assistant Examiner—Kimberly A. Williams
Attorney, Agent, or Firm—Fitzpatrick, Cella, Harper & Scinto

[57] **ABSTRACT**

An image having suitable color-tone and density is formed on a recording medium so that a full-color image of an excellent color-tone depending on a OHP can be projected, wherein a CCD separates colors of an original image to read it for converting into a RGB digital signal by an A/D conversion circuit, the process corresponding to a required image signal forming condition is executed by image process means for the digital signal to generate an image signal for outputting it to an LD driver, and a full-color image forming apparatus for forming a color image on a recording medium utilizing plural kinds of color materials based on the image signal comprises the image processing means for executing a gradation conversion process for the signals of C, M and Y in a LUT 1 circuit and executing a different gradation conversion process for a black signal Bk in a LUT 2 circuit different from a LUT 1 circuit.

11 Claims, 11 Drawing Sheets



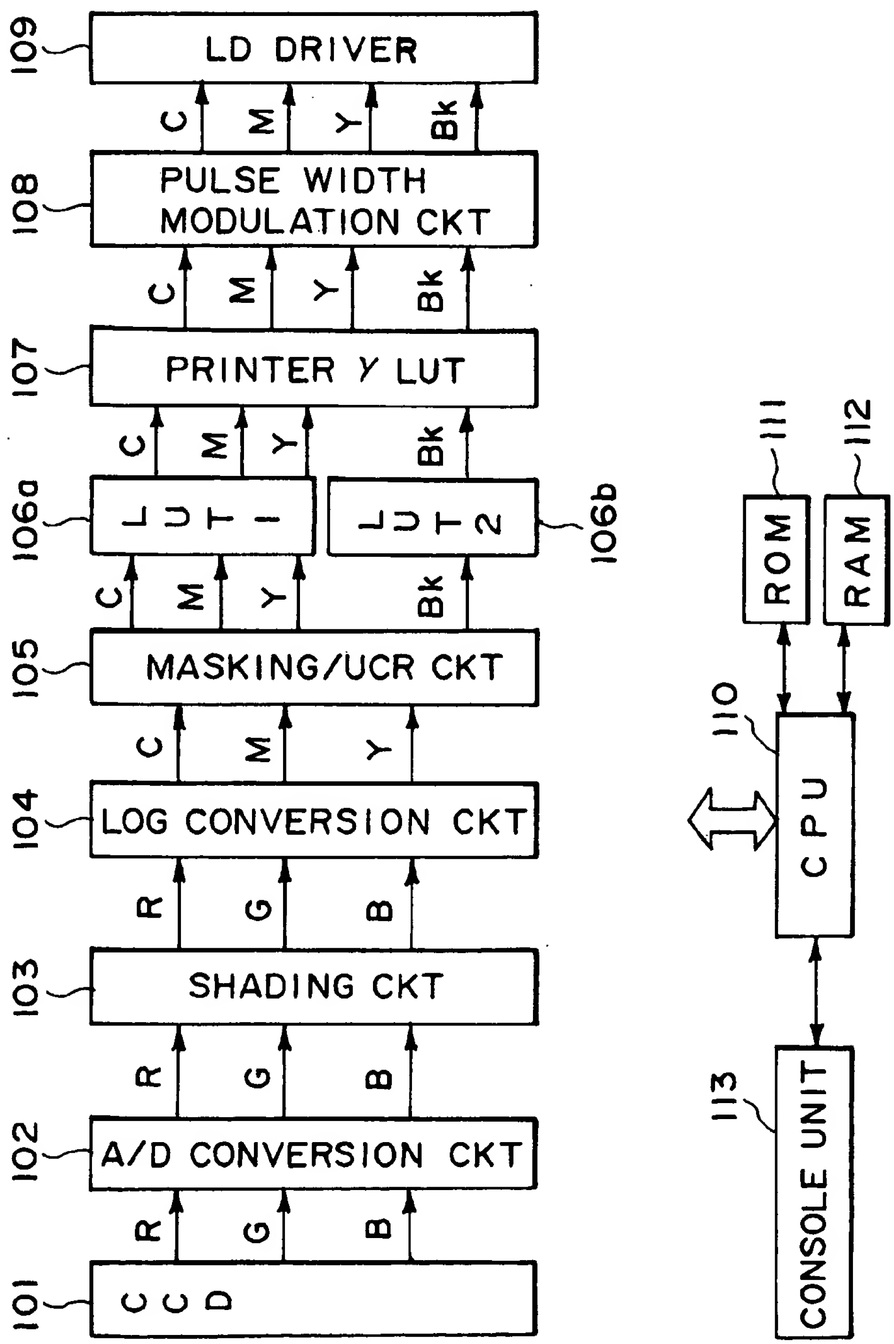
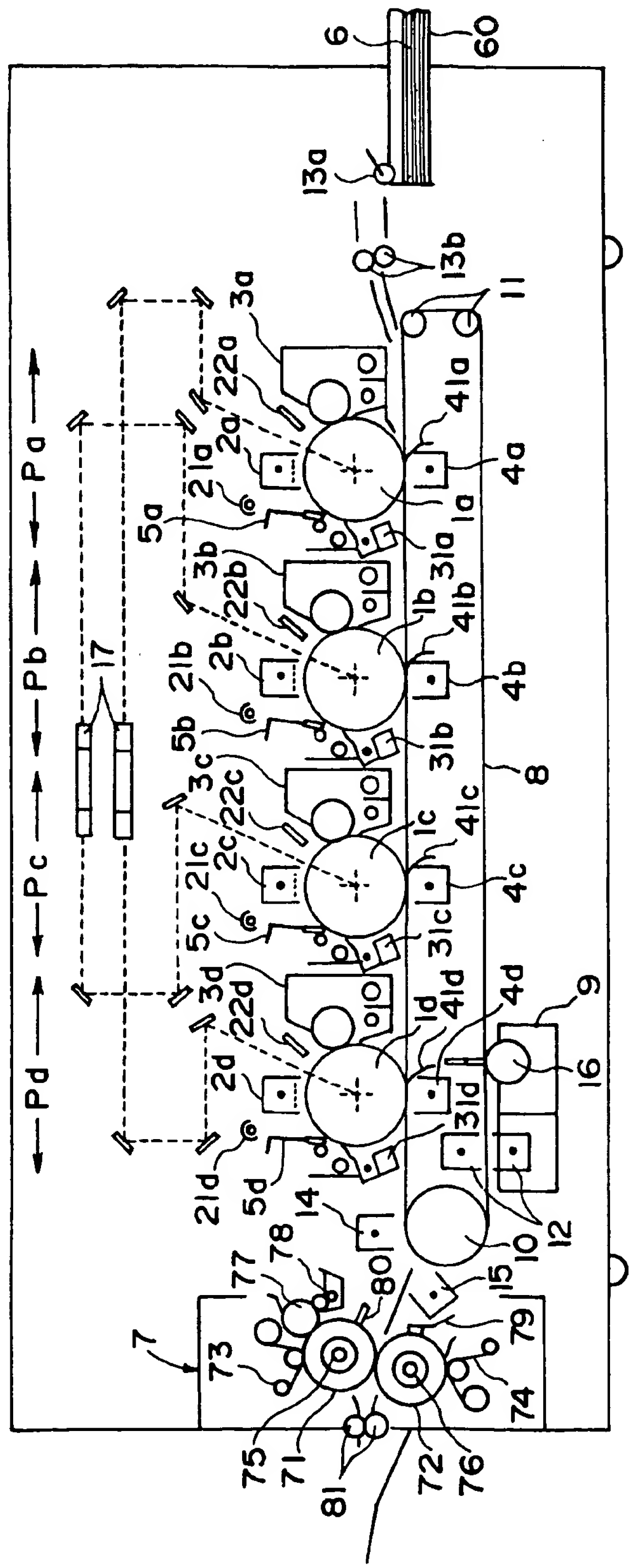

109
LD DRIVER
C
M
Y
Bk
108
PULSE WIDTH
MODULATION CKT
C
M
Y
Bk
107
PRINTER γ LUT
C
M
Y
Bk
106a
LUT1
LUT2
106b
C
M
Y
Bk
105
MASKING/UCR CKT
C
M
Y
104
LOG CONVERSION CKT
R
G
B
103
SHADING CKT
R
G
B
102
A/D CONVERSION CKT
R
G
B
101
CCD
111
112
ROM
RAM
110
CPU
113
CONSOLE UNIT

FIG. 1



6
60
13a
13b
11
3a
22a
2a
21a
5a
1a
31a
41a
4a
Pa
Pb
Pc
Pd
3b
22b
2b
21b
5b
1b
31b
41b
4b
17
8
3c
22c
2c
21c
5c
1c
31c
41c
4c
3d
22d
2d
21d
5d
1d
31d
41d
4d
9
16
12
10
14
15
7
73
77
78
80
79
74
75
71
81
72
76

FIG. 2

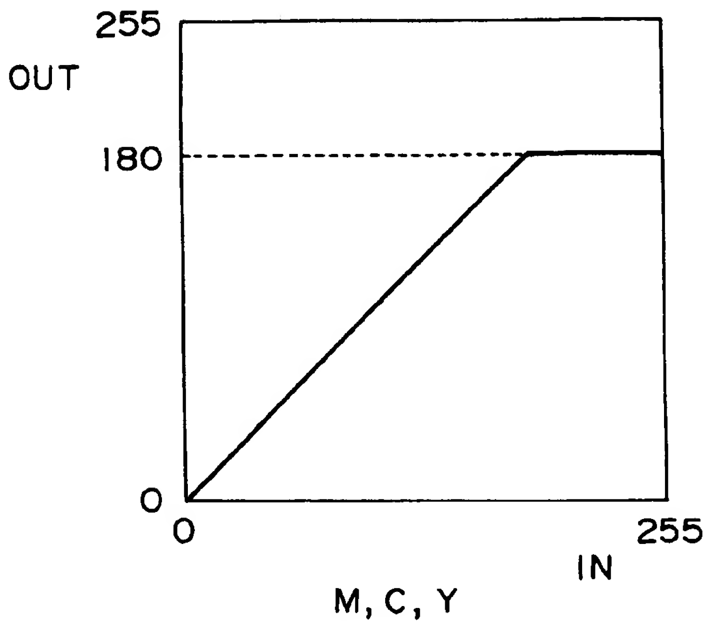


FIG. 3

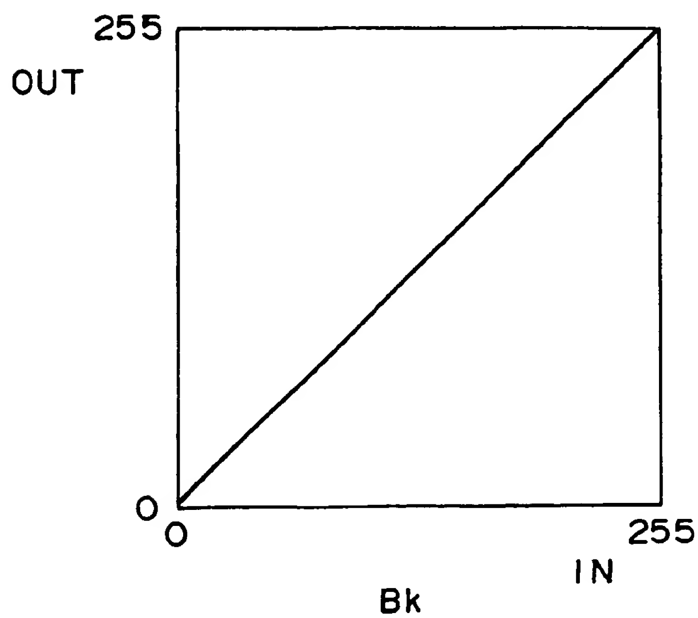


FIG. 4

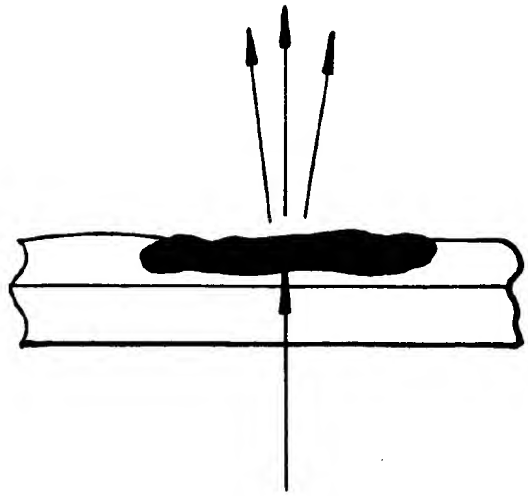


FIG. 5

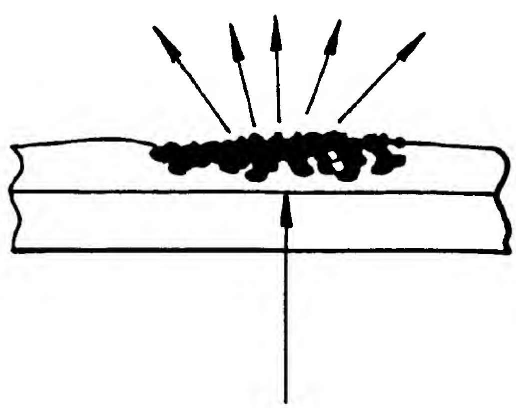


FIG. 6

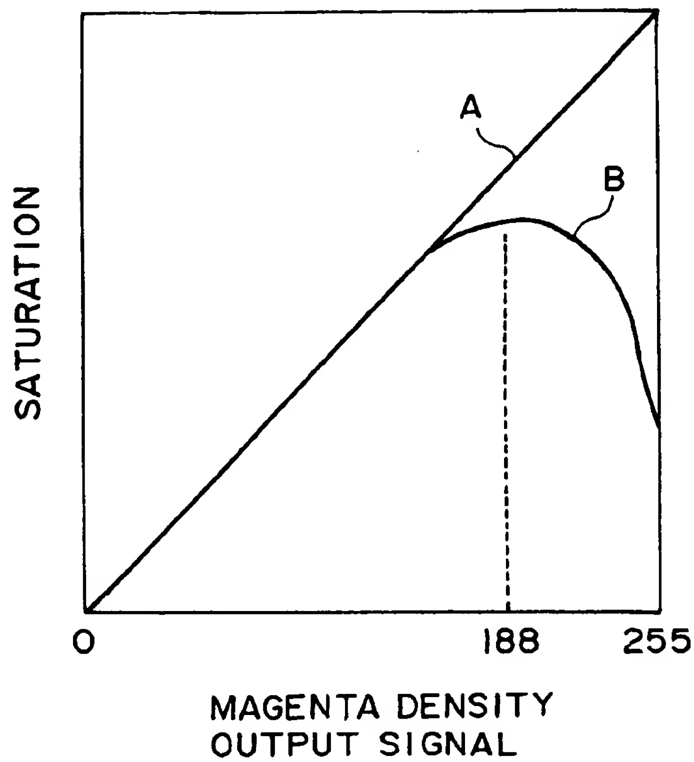

A
B
SATURATION
0
188
255
MAGENTA DENSITY
OUTPUT SIGNAL

FIG. 7

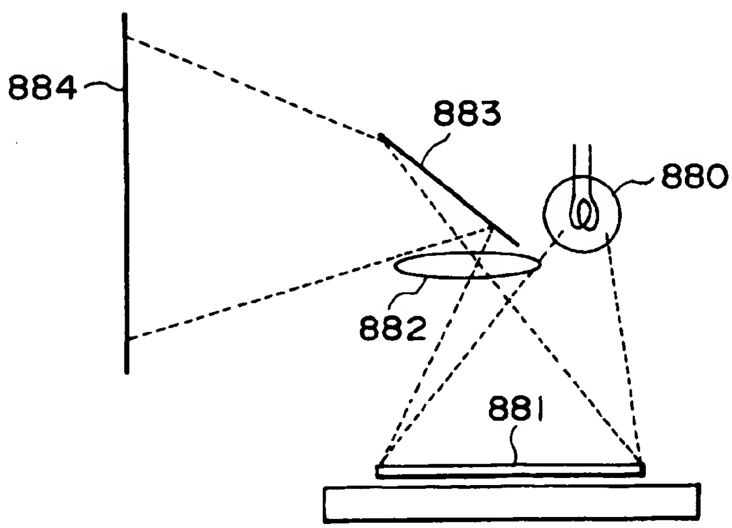

884
883
880
882
881

FIG. 8

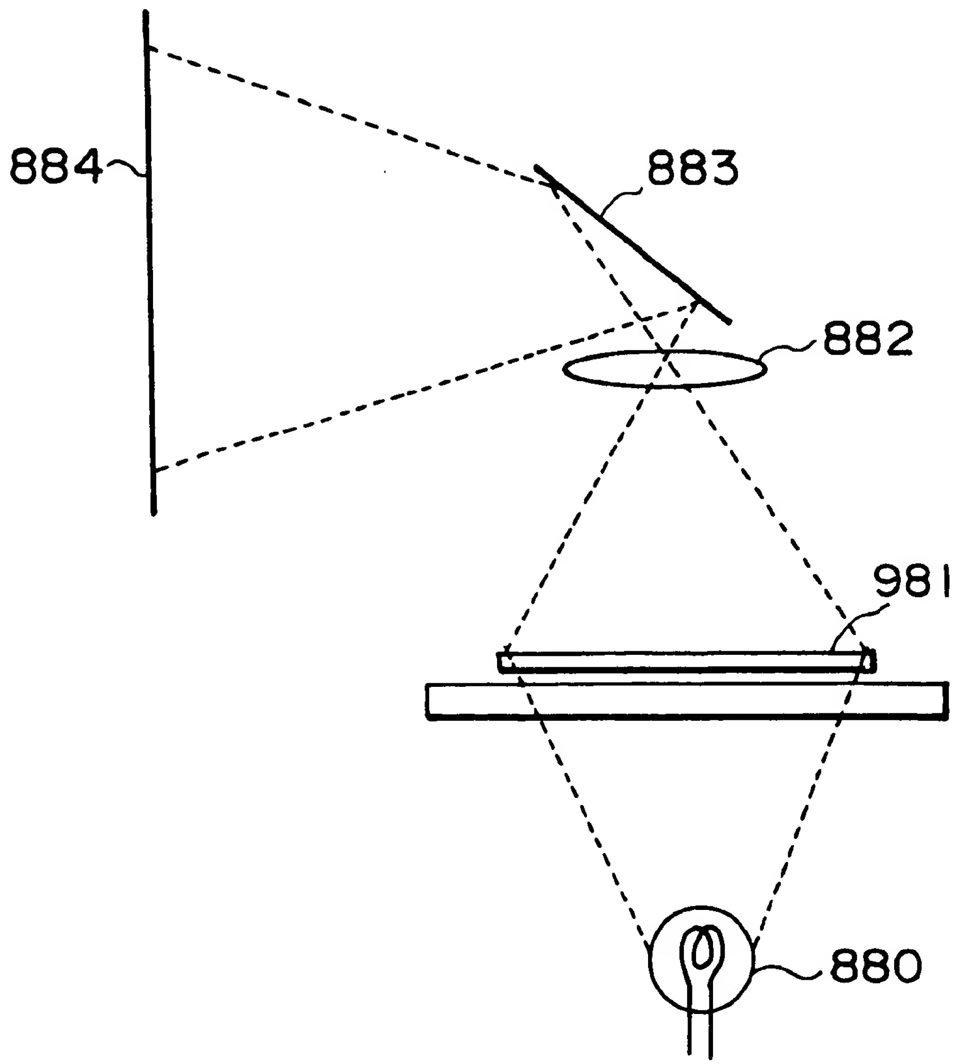


FIG. 9

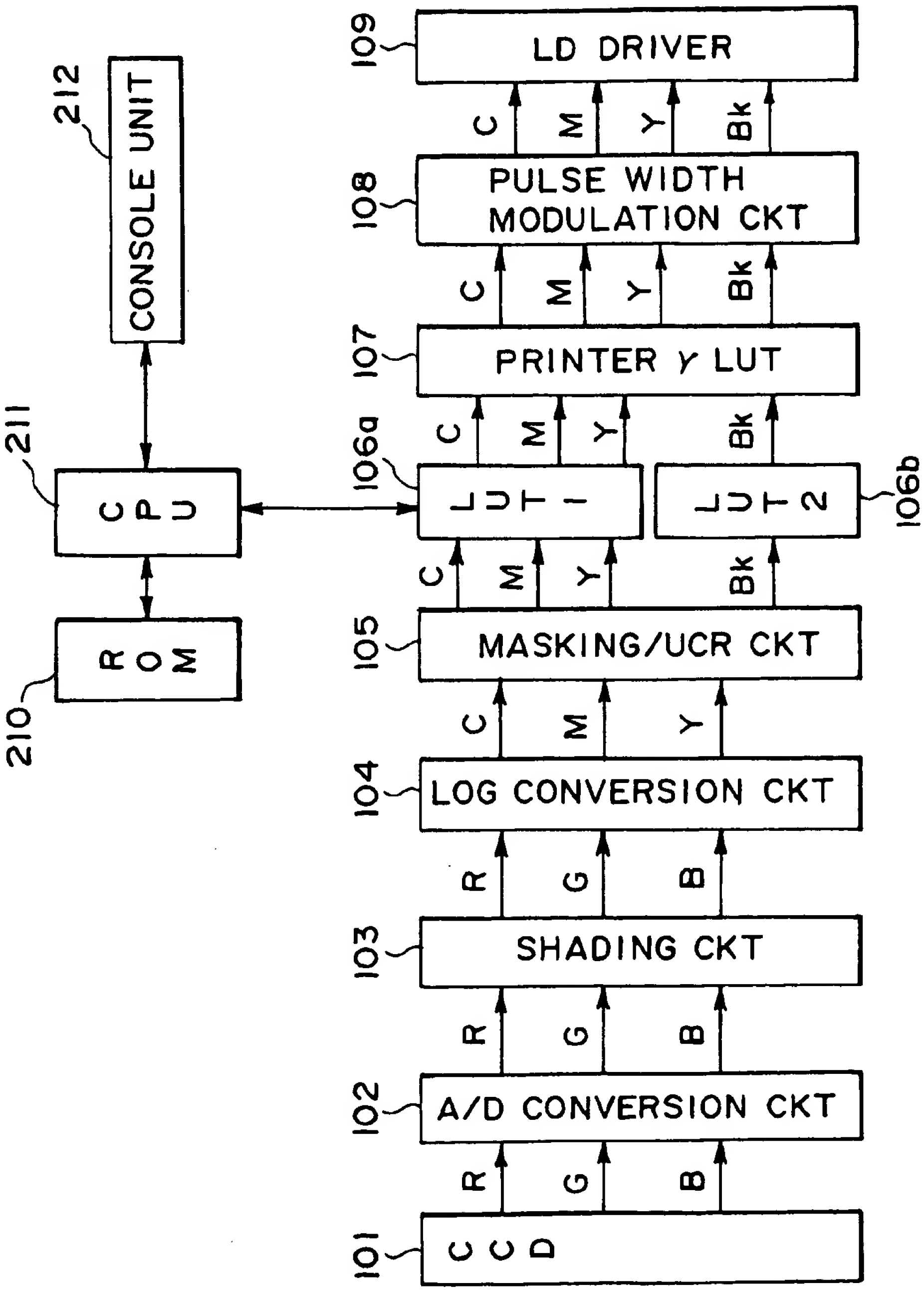
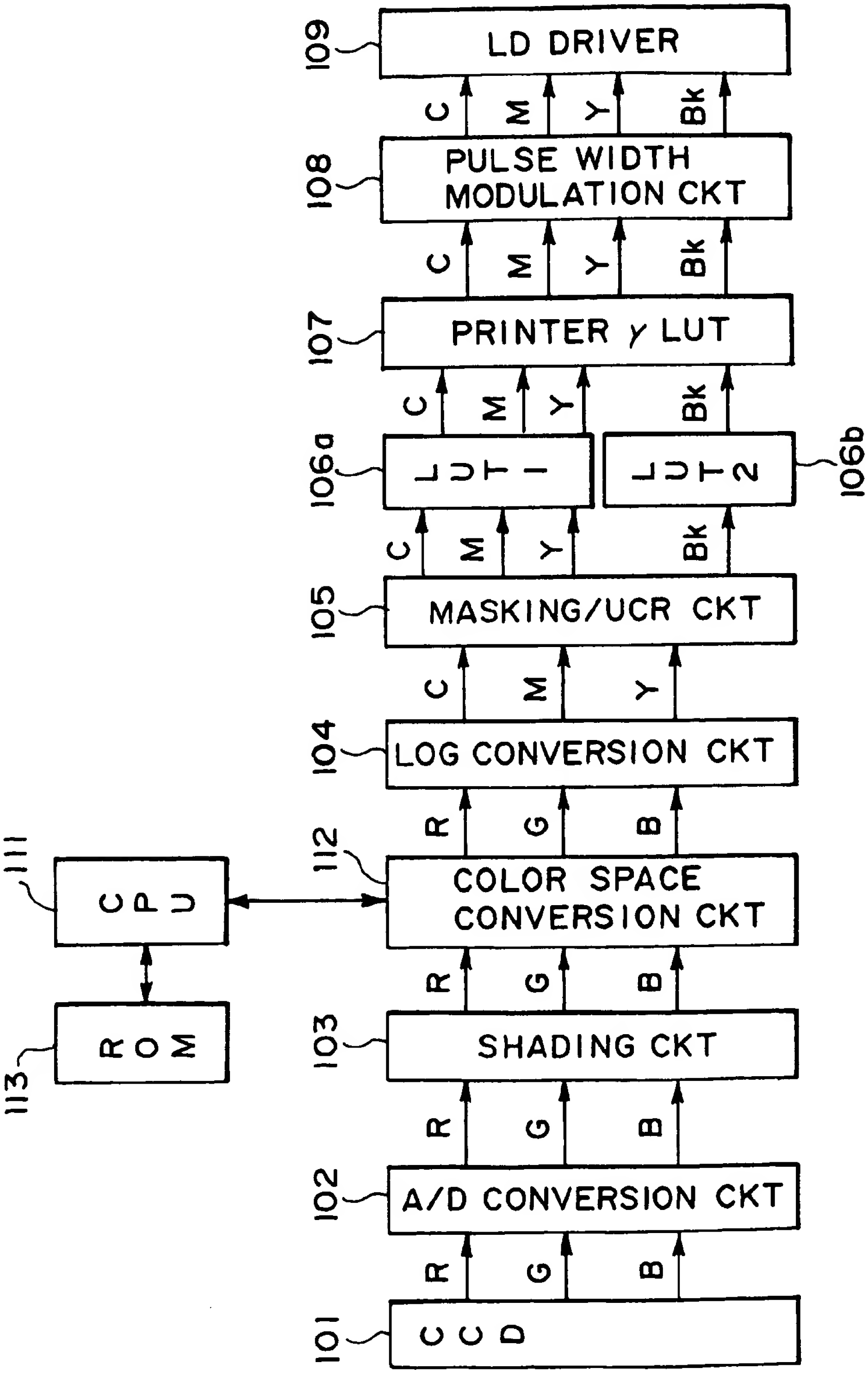

LD DRIVER
109
PULSE WIDTH MODULATION CKT
108
PRINTER γ LUT
107
LUT 1
106a
LUT 2
106b
MASKING/UCR CKT
105
LOG CONVERSION CKT
104
SHADING CKT
103
A/D CONVERSION CKT
102
CCD
101
C
M
Y
Bk
R
G
B
CONSOLE UNIT
212
CPU
211
ROM
210

FIG. 10



LD DRIVER
109
C M Y Bk
PULSE WIDTH MODULATION CKT
108
C M Y Bk
PRINTER γ LUT
107
C M Y Bk
LUT 1
106a
LUT 2
106b
C M Y Bk
MASKING/UCR CKT
105
C M Y
LOG CONVERSION CKT
104
R G B
COLOR SPACE CONVERSION CKT
112
CPU
111
ROM
113
R G B
SHADING CKT
103
R G B
A/D CONVERSION CKT
102
R G B
CCD
101

FIG. 11

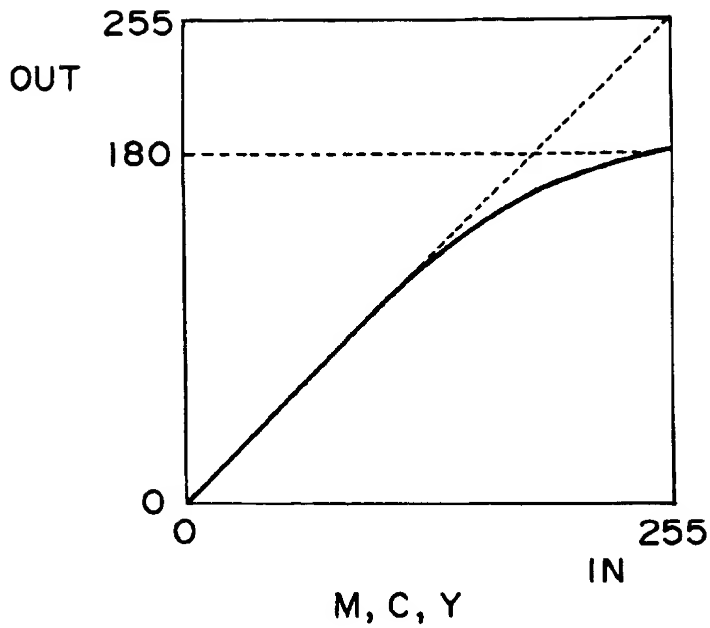


FIG. 12

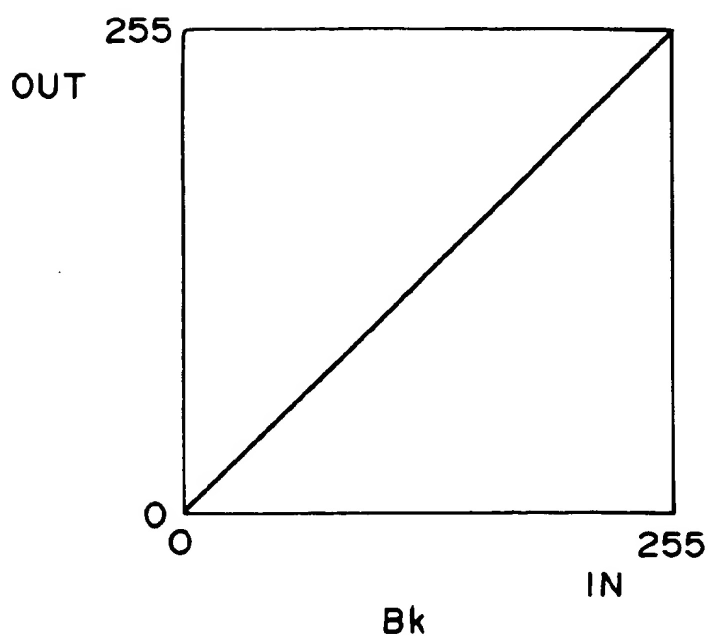


FIG. 13

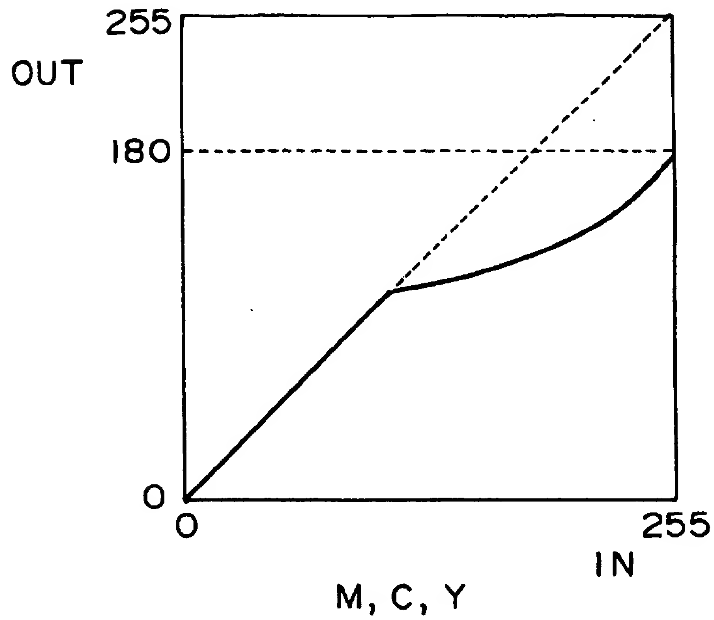


FIG. 14

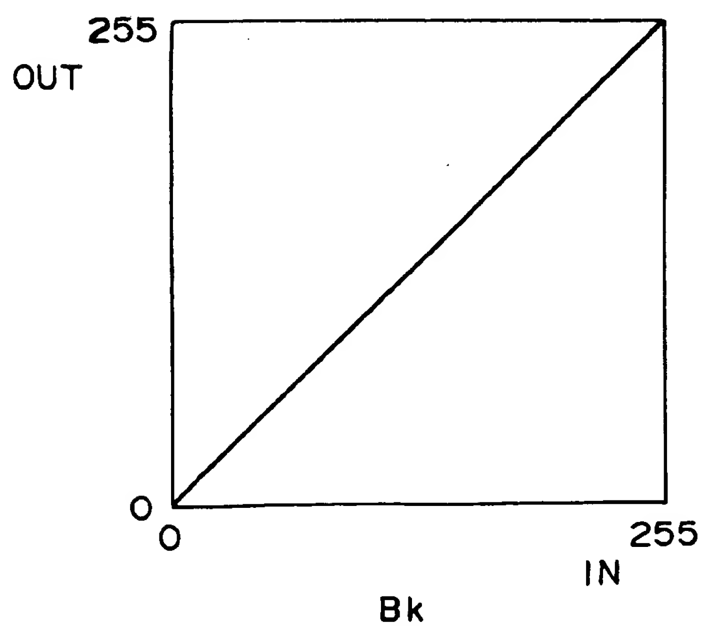


FIG. 15

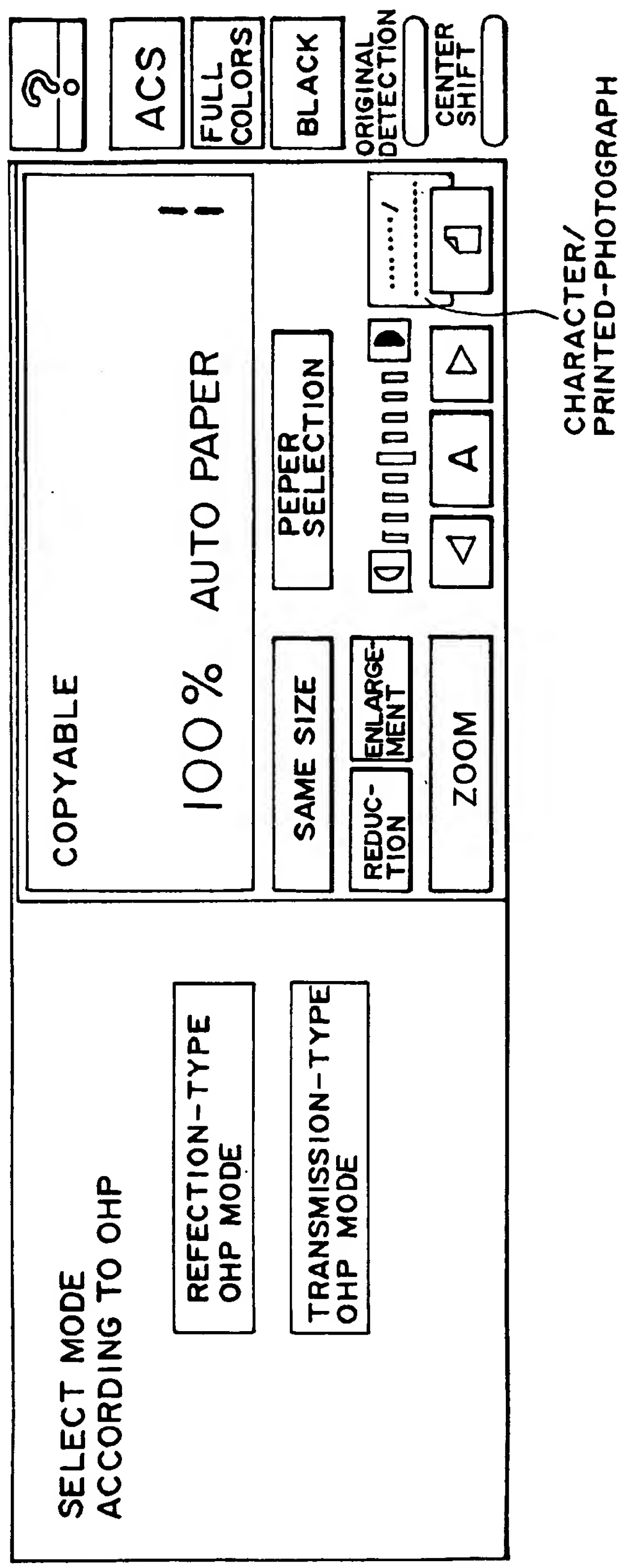

ACS
FULL COLORS
BLACK
ORIGINAL DETECTION
CENTER SHIFT
COPYABLE
100% AUTO PAPER
PEPER SELECTION
SAME SIZE
ENLARGE-MENT
REDUC-TION
ZOOM
A
CHARACTER/ PRINTED-PHOTOGRAPH
SELECT MODE ACCORDING TO OHP
REFECTION-TYPE OHP MODE
TRANSMISSION-TYPE OHP MODE

FIG. 16

IMAGE PROCESSING APPARATUS AND METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a color image processing apparatus and method for color processing images.

2. Related Background Art

Hitherto, a method for projecting images on a screen or the like by utilizing an image projector such as an overhead projector (hereinafter referred to as OHP) by forming images on a transparent sheet by a full-color image forming apparatus which depends on such methods as an electrophotography, an ink-jetting, a thermotransfer recording and the like has been widely used and an importance thereof will become more serious in future.

As an OHP image sheet, a resin sheet such as an polyethylene (PET) or the like having a thickness of 100 to 150 μm is widely used and a desired recorded image holding layer is provided on the resin sheet if it is required in order to improve a fixing, a holding or a resolution of images.

An image forming method which depends on the full-color image forming apparatus utilizing an electrophotographic method will be described hereinafter.

FIG. **2** is a structural view of the full-color image forming apparatus utilizing the electrophotographic method.

In the drawing, the apparatus consists of four stations for forming four color images of magenta, cyan, yellow and black. Photosensitive drums **1***a* to **1***d* are uniformly charged by primary chargers **2***a* to **2***d* and a light emitted by a semiconductor laser (not shown) driven by each color image signal is exposure scanned on the photosensitive drums **1***a* to **1***d* by a polygon mirror **17** to form a latent image. The latent image is developed by development devices **3***a* to **3***d* to form a toner image on the photosensitive drums **1***a* to **1***d*.

The toner image is formed by applying a recording material **6** in a recording material tray **60** on a transfer belt (or a transfer sheet) **8** through a pick-up roller **13***a* and registration rollers **13***b* and is then fed. A registration on the recording material **6** is synchronized. The image is thereafter multiple-transferred by thermotransfer chargers **4***a* to **4***d*, and is discharged outside an image forming apparatus upon fixing it on the recording material through a fixing roller **71** and a pressing roller **72** by means of a separation charger **14** and curvature of a transfer belt holding roller **10**.

Next, there will be explained as to a fixing process.

The fixing roller **71** consists of a metallic pipe of which surface is coated by a silicone rubber and a fluoro rubber. The pressing roller **72** consists of a metallic roller of which surface is coated by the silicone rubber. A thermistor **79** and a thermocontrol circuit (not shown) both mounted on a surface of the pressing roller **72** control halogen heaters **75** and **76**, so that a surface temperature of the roller **72** is maintained at a constant value suitable for the fixing process.

The silicone oil in an oil pool is removed to an oil application roller **77** through an oil pump-up roller **78** for sequentially controlling the oil application roller **77** to contact with or separate from the fixing roller **71**. Thus, a constant quantity of oil is to be held on the fixing roller **71** by an oil control blade **80**.

Cleaning devices **73** and **74** utilize zonal cleaning web members to attain an excellent cleaning with maintaining their fresh surfaces by drawing out and rolling up the web members.

In case of forming a full-color image on a transparent recording material, it is preferable to increase a fixing set temperature, to decrease a fixing feed speed or to increase a fixing pressure, as compared with a case of fixing a reflect recording material. This is because the sufficient heat is added so as not to remain the grain form of each color toner in the recorded image holding layer on a PET sheet. In order to realize such an operation, a means for delaying the fixing feed speed is generally used under a consideration of a waiting time for switching with the reflect recording material and a structural arrangement of the hardware.

However, if the fixing speed is set suitably for the transparent recording material, it is appeared an area at which a pulse motor cannot uniformly be driven. Further, since heat to be given to a PET sheet becomes unexpectedly large, the transparent recording sheet passes through feed rollers **81** in a thermoplastic state after passing through the fixing roller **71**. As a result, there occurs such a defect as the surface of a transparent recording sheet becomes worse.

It should be noted that, since probability that the fused toner adheres to the fixing roller becomes large in an area where a great deal of toner is transferred at a high concentration (or density) area of an image, there occurs such an image defect as the density of the high concentration area becomes thin. Moreover, the transparent recording sheet becomes likely to entwine around the fixing roller because of the tackiness of the fused toner. If the sheet entwines around the fixing roller, a serious damage will be occurred in an image forming apparatus.

SUMMARY OF THE INVENTION

The present invention is applied in consideration of the above-mentioned problems, and an object is to execute a color correction of the image data such that an excellent image can be formed.

Another object of the present invention is to execute a preferable color correction in accordance with a recording medium.

Still another object of the present invention is to execute a preferable color correction in accordance with the kind of a projector.

In order to attain the foregoing objects, an image processing apparatus of the present invention comprises: input means for inputting color image data consisted of plural color components, color correction means for correcting color so as to limit an output level for a predetermined color component in order to reduce the recording material quantity on forming an image and output means for outputting color image data which is color corrected.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram showing a structural example of an image forming apparatus according to the first embodiment;

FIG. **2** shows a structural example of a full-color image forming apparatus;

FIG. **3** shows a gradation conversion characteristic of M, C and Y;

FIG. **4** shows a gradation conversion characteristic of Bk;

FIG. **5** is a cross-sectional view of an OHP sheet in case where it is sufficiently fixed;

FIG. **6** is a cross-sectional view of an OHP sheet in case where it is fixed with the safety fixing speed;

FIG. **7** shows a characteristic of the relationship between a density output signal of magenta and the saturation;

FIG. 8 is a structural view of a reflection-type OHP;

FIG. 9 is a structural view of a transmission-type OHP;

FIG. 10 is a block diagram showing a structural example of an image forming apparatus according to the second embodiment;

FIG. 11 is a block diagram showing a structural example of an image forming apparatus according to the third embodiment;

FIG. 12 shows a modified example of the gradation conversion characteristic of M, C and Y;

FIG. 13 shows a modified example of the gradation conversion characteristic of Bk;

FIG. 14 shows a second modified example of the gradation conversion characteristic of M, C and Y;

FIG. 15 shows a second modified example of the gradation conversion characteristic of Bk; and

FIG. 16 shows an example of a console unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described with reference to a full-color image forming apparatus which can form a full-color image not only on an ordinary opaque sheet but also on a transparent recording medium used for an OHP.

The full-color image forming apparatus of the present invention reads an original image with performing a color separation to digitalize a read signal. An obtained digital signal is processed in accordance with a necessary image signal forming condition and then output, so that a color image is formed on a recording medium by several color materials on the basis of the output image signal. Thus, constituted full-color image forming apparatus has almost the same structure as that described in FIG. 2. The present embodiments are characterized in generating and processing an image signal for forming a full-color image on a transparent recording medium used for the OHP. The above featured structural portions of the embodiments will be described hereinafter.

First Embodiment

An embodiment of the present invention will be described in detail hereinafter with reference to the accompanying drawings.

FIG. 1 is a block diagram showing an entire structure from a charged coupled device (CCD) **101** to an LD driver **109** which drives a semiconductor laser of the present embodiment.

An original is lighted by a light source (not shown) and an obtained reflected light is focused on the CCD **101** by an optical lens system, thereby converting it into an electrical signal. Thus, image data indicating the original is generated.

The CCD **101** has a shape in which a three-line array is arranged. Color separating filters of red (R), green (G) and blue (B) are coated on a surface of the CCD element every one line, and a color signal corresponding to each color component of one pixel is generated.

The analog image data is converted by an analog-to-digital (A/D) converter **102** into 8-bit digital signal. Then, the obtained digital is normalized, on the basis of a luminance signal, by a shading circuit **103**, so as to eliminate variation among elements of the CCD **101**.

By a log conversion circuit **104**, R, G and B luminance signals are then converted into cyan (C), magenta (M) and yellow (Y) density signals of which colors of C, M and Y are respectively complementary colors of R, G and B.

Next, a masking process for matching color reproductivity and an under color removal (UCR) process for generating a black (Bk) signal are executed in a masking/UCR circuit **105**.

For the C, M and Y density signals indicating chromatic color components, a gradation conversion process is executed in a look-up table (LUT)1 circuit **106***a*. On the other hand, for the black (Bk) signal indicating achromatic color component, a gradation conversion process is executed in a LUT 2 circuit **106***b*.

It should be noted that a gradation conversion corresponding to a mode (normal mode or transparent recording medium mode) set in a console unit **113** is set by a CPU **110**, in the LUT 1 circuit **106***a* and the LUT 2 circuit **106***b*.

For the C, M and Y density signals which have been gradation-conversion processed in the LUT **1** and the LUT **2**, a non-linear gamma process set for each color is executed in a printer gamma LUT **107** in accordance with a printer output characteristic.

A pulse width modulation circuit **108** performs a pulse width modulation by comparing each of the input digital C, M, Y and Bk density signals with a predetermined triangle wave, independently, to convert into analog C, M, Y and Bk density signals. Then, the analog C, M, Y and Bk density signals are output to corresponding color parts of the LD driver **109**, respectively.

The LD driver **109** forms a latent image on a photosensitive drum in the electrophotographic method, on the basis of the input analog C, M, Y and Bk density signals.

It should be noted that the CPU **110** controls the foregoing each circuit on the basis of a program stored in a ROM **111**, by using a RAM **112** as a work-memory.

Next, the gradation conversion process of the LUT 1 and the LUT 2 in the transparent recording medium mode and the normal mode will be described.

(I) Transparent Recording Medium Mode

A conversion characteristic in the transparent recording medium mode is indicated by FIGS. **3** and **4**.

FIG. **3** indicates the conversion characteristic of the gradation conversion process of the LUT 1 circuit **106***a*, and FIG. **4** indicates the same as that of the LUT 2 circuit **106***b*.

As shown in the drawings, the Bk signal has the conversion characteristic for outputting the input signal as it is, while the signals of M, C and Y are set to limit the output signal not exceeding the level **180**.

The reason for setting like this will be described hereinafter.

FIGS. **5** and **6** are cross-sectional views in a case where an image is formed on a transparent recording material.

FIG. **5** indicates the state that an image is sufficiently fixed under the condition that a fixing temperature is set at 160° C. and a fixing speed is set at 25 mm/sec. In this case, toner grains are sufficiently fused and dispersed in the recorded image holding layer without having the grain shape, and the diffusion of the transmitting light can not be almost observed.

In such a state, a hue of the image projected to a screen by utilizing an OHP sheet on which the image is formed by color toners of M, C and Y is clear, and the image having excellent color productivity can be obtained.

However, if the fixing speed is set more slowly than that of ordinary case in order to set the fixing speed suitable for the transparent recording medium, it is appeared an area at which a pulse motor cannot uniformly be driven. Further, since heat to be given to a PET sheet becomes unexpectedly large, the transparent recording sheet passes through feed rollers **81** in a thermoplastic state after passing through the

fixing roller. As a result, there occurs such a defect as the surface of a transparent recording sheet becomes worse. Further, probability that the fused toner adheres to the fixing roller becomes large in an area where a great deal of toner is transferred at a high concentration (or density) area of an image. Therefore, there occurs such an image defect as the density of the high concentration (or density) area becomes low. Moreover, due to tackiness of the fused toner, a serious damage will be occurred in the image forming apparatus, this fact may become the fatal defect for the image forming apparatus.

FIG. 6 indicates the state of being executed the fixing under the condition that a fixing temperature is set at 160° C. and a fixing speed is set at 75 mm/sec to avoid the above fatal defect.

In this case, the toner grains are not sufficiently fused because of the insufficient heat, and a toner's grain structure is partially remained. Due to this fact, the incident light is diffused, and the hue of the projected image utilizing the OHP sheet with color toners of M, C and Y becomes hardly diffused as the quantity of toner grows large. As a result, the color of muddy black is appeared.

FIG. 7 shows the characteristic of the relationship between a density output signal and saturation. In FIG. 7, A indicates the characteristic when the fixing speed is set at 25 mm/sec, and B indicates the characteristic when the fixing speed is set at 75 mm/sec.

According to a curve indicated by B, it is understood that blur (or muddiness) is appeared from about **180** level in the density output signal value.

That is, as described above, it is understood that the toner grains are not sufficiently fused because of the insufficient heat.

As above, in case of utilizing the transparent recording medium, a large heat is required in order to fuse the toner grains as compared with the case of utilizing an ordinary sheet.

However, if the fixing speed is delayed in order to give the sufficient heat capacity, there occurs the above-mentioned problems.

While, even if the fixing temperature is increased, such another problem as the state of thermoplasticity or the like will be occurred.

Therefore, in the present embodiment, as apparent from FIG. **7**, the quantity of toner has to be limited such that the toner grains can be sufficiently fused under the normal fixing temperature and speed in the transparent recording medium.

That is, as to the chromatic components of M, C and Y, even if a density input signal exceeding the level **180** exists, as shown in FIG. **3**, the quantity of toner has to be limited such that an upper limitation does not exceed the level **180**.

In the present invention, in consideration of a total image quality, an image having no extraordinary impression can be formed by avoiding the generation of blur (or muddiness).

While, as to the achromatic component of Bk, character information becomes important at a level exceeding the level **180** in the character reproduction quality, and the probability that the level of Bk does not exceed the level **180** is extremely large in a gradation image area due to the UCR processing when an image is in the normal state. In this point of view, it is not required to set any limitation for the component Bk.

As described above, in the transparent recording medium mode, the quantity of toner is limited such that the toner can be fused under the heat capacity to be given by the normal fixing temperature and speed.

Further, as to the achromatic component of Bk, since reproductivity with the high level becomes important in black characters or the like, it is not required to limit the achromatic component of Bk but is required to limit the chromatic components of Y, M and C.

Accordingly, the blur (or muddiness) in color can be prevented, the color can be reproduced clearly, and the black character can be reproduced excellently.

(II) Normal Mode

In a case where a normal mode is designated, an image can be excellently reproduced until the high density portion, at the normal fixing speed and temperature.

Therefore, the quantity of toner has not to be limited at the LUT **1**, but the gradation conversion process shown in FIG. **4** has to be executed for entire colors of C, M, Y and Bk.

That is, for the LUT **1** and the LUT **2**, a gradation conversion table shown in FIG. **4** has to be set.

As described above, according to the present embodiment, the most suitable process in accordance with the kind of the recording medium can be executed.

By providing the above setting, as to an image projected by the OHP, especially by a reflective type OHP, an excellent quality can be obtained.

Second Embodiment

In the first embodiment, the most suitable state can be realized for the case where an image is projected by, especially, the reflection-type OHP.

However, in a case where an image is projected by a transmission-type OHP, the color may be observed thin in an OHP image formed under the condition of the first embodiment.

FIG. **8** is a structural view of the reflection-type OHP and FIG. **9** is a structural view of the transmission-type OHP.

In the reflection-type OHP shown in FIG. **8**, a light source **880** irradiates an OHP original **881**, and the reflected light is projected on a screen **884** via a lens system **882** and a mirror **883**.

In this case, since the light passes through the OHP original two times, the light is also shielded and diffused respectively two times. This fact causes a great loss of the light until reaching to a screen.

On the other hand, in a case where a transmission-type OHP is used, since the light passes through an OHP original **981** only one time, resulting in a little loss of the light.

Therefore, in a case where a transmission-type OHP is used, since the loss of light is relatively small, it is almost needless to notice a color blur (or muddiness). Accordingly, the process having an importance on reproducing the color deeply is executed.

Therefore, in the present embodiment, as shown in FIG. **10**, the most suitable condition fitting to the different type of OHP is registered in a ROM **210** for being selected by an user with a display screen of a console unit **212** shown in FIG. **16**, and a CPU **211** loads the LUT value to be switched the parameter.

As a definite parameter of the transmission-type OHP, the gradation conversion characteristics of M, C and Y are set to the same as that of black Bk shown in FIG. **4**.

Accordingly, the most suitable OHP sheet can be provided in accordance with the kind of OHP which is often used by an user.

Here, the description is given by utilizing only two modes, however, it is needless to say that the most suitable condition corresponding to the used OHP can be selected by varying the limiting value on a console unit.

Further, it is effective to modify the gradation conversion characteristic to a non-linear curved shape.

Further, the combination of the gradation conversion characteristic to be set in a LUT **1** and a LUT **2** may be such combinations as shown in FIGS. **12** to **15**.

That is, a non-linear gradation conversion characteristic is set for the LUT 1 so that an excellent gradation may be maintained until the input level **255**.

A printer gamma LUT **107** may be properly set to be corresponded to the varying of the output characteristic of a printer according to a calibration or the like.

The LUT **1** and the LUT **2** may be set so that the CPU controls and corrects the foregoing gradation conversion characteristic which is set with the mode corresponding to the foregoing recording medium for setting a table on the basis of the color-balance set by a console unit or the kind of images (characters, photograph or map).

Third Embodiment

In the above described embodiment, the most suitable OHP image was obtained utilizing the gradation conversion of a gamma LUT, however, in the present embodiment, it is characterized that a desired characteristic can be obtained by a color space conversion.

FIG. **11** is a block diagram of the third embodiment.

As shown in FIG. **11**, a color space conversion circuit **112** is provided between a shading circuit **103** and a LOG conversion circuit **104**.

Here, the present embodiment is supported by the following matrix calculation, and for an entire color space, the luminocity, the hue and the saturation can be controlled depending on the parameter of a matrix.

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} a1 & a2 & a3 & R \\ a4 & a5 & a6 & G \\ a7 & a8 & a9 & B \end{bmatrix}$$

If the OHP mode is selected, the same effect as that of the first embodiment can be obtained under the setting of without using the high-density to increase the luminocity.

As described above, according to the present invention, when an image is formed on a transparent recording medium, the image signal with the different image signal forming condition depending on the image signal process means is to be output against a black image signal portion and a color image signal portion, respectively, and the image forming means forms a color image on the transparent recording medium utilizing plural color materials on the basis of the image signal. This formed image can be projected as a full-color image having excellent colors by an image projector (OHP).

Further, depending on the constitution that a control means stores a mode setting the most suitable image signal forming condition against the kind of an image projector and such a mode can be selected by an user, an image to be projected with an excellent color-tone/density full-color image corresponding to the kind of OHP can be easily formed for an user who utilizes several kinds of OHPs.

As above, the description was given based on the preferable embodiments, however, the present invention is not limited to the foregoing embodiments but many modifications and variations are possible within the spirit and scope of the appended claims of the invention.

What is claimed is:

1. An image processing apparatus comprising:

input means for inputting color image data comprising plural color components; and

color correction means for performing color correction in accordance with one of plural modes that correspond to recording media, the plural modes including a transparent recording medium mode and an ordinary sheet mode;

wherein, in the transparent recording medium mode, the color correction means performs color correction to limit an output level of a predetermined color component such that a quantity of recording material used for image formation is reduced relative to a quantity of recording material used for image formation in the ordinary sheet mode.

2. An apparatus according to claim **1**, wherein the plural color components comprise a chromatic component and an achromatic component.

3. An apparatus according to claim **2**, wherein the predetermined color component is a chromatic component.

4. An apparatus according to claim **1**, wherein the color correction performed by said color correction means comprises gradation correction.

5. An apparatus according to claim **4**, wherein gradation correction to clip the input equal to or larger than a predetermined value is performed on the predetermined color component.

6. An apparatus according to claim **4**, wherein the gradation correction for the predetermined color component is non-linear.

7. An apparatus according to claim **1**, further comprising:

generation means for generating the color image data by scanning an original image; and

image formation means for forming an image on a transparent recording medium on the basis of color image data which has been color corrected.

8. An apparatus according to claim **1**, wherein said color correction means performs a color space conversion.

9. An image processing apparatus comprising:

input means for inputting color image data which indicates a target image; and

color correction means for performing a color correction of the color image data to form an image on a transparent recording medium,

wherein said color correction means performs the color correction corresponding to a kind of a projector to be used for projecting the transparent recording medium.

10. An image processing method comprising:

an input step of inputting color image data comprising plural color components;

a color correction step of performing color correction in accordance with one of plural modes that correspond to recording media, the plural modes including a transparent recording medium mode and an ordinary sheet mode;

wherein, in the transparent recording medium mode, the color correction step performs color correction to limit an output level of a predetermined color component such that a quantity of recording material used for image formation is reduced relative to a quantity of recording material used for image formation in the ordinary sheet mode.

11. An image processing method comprising:

an input step of inputting color image data which indicates a target image; and

a color correction step of performing a color correction of the color image data to form an image on a transparent recording medium,

wherein, in said color correction step, the color correction corresponding to a kind of a projector to be used for projecting the transparent recording medium is performed.

* * * * *